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COAL HANDLING FOR LARGE BOILER PLANTS.

THE economy which has been achieved by substituting mechanical for hand labor is nowhere more evident than in the large plants which have been erected for supplying our cities with water, light and power; and this is especially true of the appliances which are in use for handling the vast supplies of coal which have to be stored within reach of the boiler house. In the old days of the hand shovel, the cost of coal handling was a serious item in the weekly pay roll; moreover, hand shoveling was slow and cumbersome. With the introduction of automatic appliances, it was natural that attention should be drawn to the question of the transportation and storage of coal, and the efforts of engineers in this direction have furnished the large steam plants of to-day with very highly developed and economical machinery.

The accompanying illustrations show how the problem of coal handling has been worked out at the Ridgewood Pumping Station of the Brooklyn Water Works, and at the power stations of two of the Brooklyn street railway companies.

The Ridgewood Pumping Station has a total pumping capacity of 110,000,000 gallons in 24 hours. The plant consists of two double acting beam engines, a crank engine by Hubbard & Whittaker, of Brooklyn, and a compound condensing engine, running duplex or single. These four engines have a capacity of 60,000,000 gallons a day. There are also five Worthington compound condensing high duty engines with a capacity of 50,000,000 gallons per day. The boiler plant for the Worthington pumps consists of six Biglow boilers, and four internally fired, return flue, tubular boilers, the coal consumption being about 120 tons per day.

The coal is brought to a large coal storage building (of which we show an interior view in Fig. 1) in railroad dump cars and discharged into a hopper situated below the tracks. The car tracks run across one end of the building on a covered track way, and at the other end of the building are the engine and boiler for running the conveyor. The latter consists of a series of gravity buckets pivoted in a double chain and carried on self-lubricating wheels. The buckets are hung on pins which are riveted to the sides of the buckets near the top edges in such a position that the force of gravity will always keep the buckets in the vertical position in whatever direction the conveyor may be running. The conveyor is carried on metal tracks, as shown in Fig. 1, which run down the center of the storage building in what is known as the monitor. The driving power is supplied at the engine end of the building and is applied by means of pawls in place of sprocket wheels, the object being to avoid the excessive wear which ordinarily occurs in this class of conveyors. Since the buckets swing freely on pivots, it was necessary to adopt some special method for filling them, otherwise, if the coal were allowed to run directly into them from the hopper, they might oscillate too much or hang out of the vertical and not receive a full load. To prevent this irregularity an ingenious endless filler is provided which consists of a chain of rectangular funnels rotating above and at the same speed as the conveyors. This is placed beneath the hopper and serves to guide the coal centrally within the buckets. The loaded buckets are carried vertically the required height to the monitor and, moving horizontally down the long storage building, they discharge the coal in any desired place. The empty buckets return overhead, as shown in the illustration.

As the coal is received intermittently it is an object to unload the cars as rapidly as possible, and the conveyor at this station is made sufficiently large to unload a 30 ton car in 30 minutes. It should be noted that the size of these conveyors in such a plant as this is determined, not by the daily consumption but by the rapidity with which the coal must be received at the hopper. The storage building has a total capacity of 4,000 tons of coal.

Power for the Brooklyn Heights Railroad Company is furnished from two power stations, one on Kent Avenue and the East River, in the eastern part of the city, and the other situated in South Brooklyn, at the foot of Fifty-second Street and New York Bay. Owing to the great value of the Kent Avenue station it was judged advisable to build as concentrated a plant as possible, and it is claimed that the station contains the greatest power per square foot of ground area combined with large storage capacity of any power station in the United States. The plant consists of six 2,500 horse power cross compound Allis engines direct connected to the generators, each unit having a capacity of 3,800 amperes at 500 volts. Steam is furnished by thirty-six 275 horse power Babcock & Wilcox boilers situated on two floors.

The coal is ordinarily received from vessels; but arrangements were also made by which, in case of the failure of the supply by water, it could be unloaded from the wagons of the local dealers. This is accomplished by providing two unloading hoppers, one on the floor of the steam shovel elevator, shown in Fig. 2, for receiving the coal as it is unloaded from the ships and barges, the second hopper being on the floor of the wharf, where coal may be unloaded direct from the wagons. The conveyor passes out through the wall of the building, descends to the elevator platform, passes through the elevator and down through the floor of the dock. Here it returns below the floor to the wall of the building and ascends to re-enter by the same opening through which the empty buckets come out. The elevator consists of a parabolic latticed steel boom which projects from the top of the elevator tower out and down over the water. Its lower members form a trackway on which runs a four wheeled traveler, which is provided with two sheaves, one of which carries the hoisting chain, and the other the wire cable for closing the steam shovel. The traveler is held in the desired position over the hold of the vessel by suitable stops. The traveler runs out by gravity to the stops, where the shovel is lowered in the open position as shown in Fig. 3. When the hoisting engine is started the scoop shuts automatically, inclosing a ton of coal. It is then hoisted, drawn into the tower, and dumped into the hopper. Here it is drawn off by a filler, similar to the one already described, loaded into the conveyor, and taken up to a pocket, situated above the boilers, and 100 feet above the wharf, which has a capacity of 6,000 tons.

The C. W. Hunt Company, of New York, who are the builders of both the conveyor and the elevator and shovel, have also put in an extensive plant at the Fifty-second Street station above mentioned. Here the work differs in several respects from that at the Kent Avenue station. The coal is unloaded from vessels lying at the end of a pier 800 feet long, and it has to be delivered to a storage building holding 8,000 tons, situated near the boiler room. The storage building is separated from the boiler house by a water tank 90 feet wide, and the coal conveyor is carried across this by a steel truss. It is unloaded at the wharf by an elevator similar to that already described, the hoisting engine within the tower being supplied with steam from the main boilers 800 feet distant. The elevator is movable on the trestle and can be placed opposite any hatch of the vessel which is being unloaded. The coal is unloaded into cars which travel to the storage building on a cable railway. The cars, each of which holds 2½ tons, have their bottoms inclined each way from the center to the sides, and the coal is discharged automatically on both sides of the track at any point in the coal pocket. The cars run at slow speed, the required capacity being obtained by increasing the number of the cars. In passing around the curve in the storage building, provision has been made for a wide easy turn, and the cable runs on a large number of self-lubricating carrying wheels as shown in cut No. 5. It has been found that the durability of the cable is thereby considerably increased and ease of running is facilitated.

Before the present plant was put in, the coal was unloaded at the same wharf, so that a good opportunity is afforded for a comparison of results. It is stated that the cost of handling has been reduced from 27½ to 3½ cents per ton, all expenses and the interest on the investment being included in this estimate.

FIG. 1.—COAL CONVEYOR IN THE COAL STORAGE BUILDING OF THE RIDGEWOOD STATION, BROOKLYN WATER WORKS.

SOME remarkable performances in the matter of drilling steel have been accomplished in the United States with drills in the bodies of which have been inserted tubes conveying oil under pressure to the point. With such a drill a hole ¾ inch in diameter has been drilled through steel to a depth of 12 inches in fifteen minutes. The speed of rotation was 1,000 turns per minute, and the oil was supplied at the rate of two gallons per minute.

MEASURES THE BRIDGE STRAIN.

AN INSTRUMENT THAT INDICATES ONE PEDESTRIAN'S FOOTFALL.

Refinements of measurement have, within recent years, reached such incredible limits as to tax the imagination, not to speak of the credulity, of the layman who has not kept himself in touch with the marvelous progress that has been made in this direction. Prof. Vernon Boys, for example, claims to be able, with the simplest possible arrangement of a quartz fiber, torsional balance and mirror, to detect the attractive force of the one-twenty-thousand-millionth of a grain. The figures are literally so vast that they carry practically no illumination whatever. The mind, the ordinary mind, at least, cannot have even a remote perception of a grain divided into twenty billion parts.

Our natural senses hardly suffice to detect the difference in weight, by hand, between a couple of oranges weighing, say, respectively three and five ounces.

In making high power microscopes the lenses are, to all intents and purposes, flat; that is, no ordinary eye could detect their curvature, which is often no more than 1-150,000 of an inch. In order to liquefy air, Prof. Dewar, of London, desired to attain the nearest approximation to a perfect vacuum. Air has a pressure of fifteen pounds to the square inch, and this is called an atmosphere, in technical language. We do not feel this pressure ordinarily, but Prof. Dewar succeeded in gaining a vacuum of 1-25,000,000 of an atmosphere by filling a vessel with mercurial vapor and exposing it to a very low temperature.

Next as regards angles. It would be quite impossible to detect with the eye a penny at a distance of 1,000 feet. Supposing it were 1,000 miles away, the angle formed by its diameter at this distance would be so incredibly small that we have no means of picturing it to ourselves. But the Darwin pendulum will indicate a movement of 1-300 of a second, which is just about the angular measurement of a penny at this distance of 1,000 miles.

Prof. Langley's bolometer measures the temperature of the sun, though that orb is 93,000,000 miles away. A galvanometer has been devised so sensitive that it will show the electric current set up by the difference in temperature between two contiguous fingers of your hand, even if a very good thermometer shows no difference of warmth whatever. One per cent. of arsenic in copper does not seem a great deal, but if there be but three one-thousandths of one per cent. in a copper wire, it is unfit for use electrically. Chemical analysis in every day use detects this difference, and even very small fractions of such difference. It is not at all an unusual thing to see a solution marked as containing 0·00001 of a gramme, and an assay balance works down to one one-hundredth of a milligramme. A diamond weighing a carat is not an extraordinary affair, but the same balance will weigh down to one one-thousandth of this.

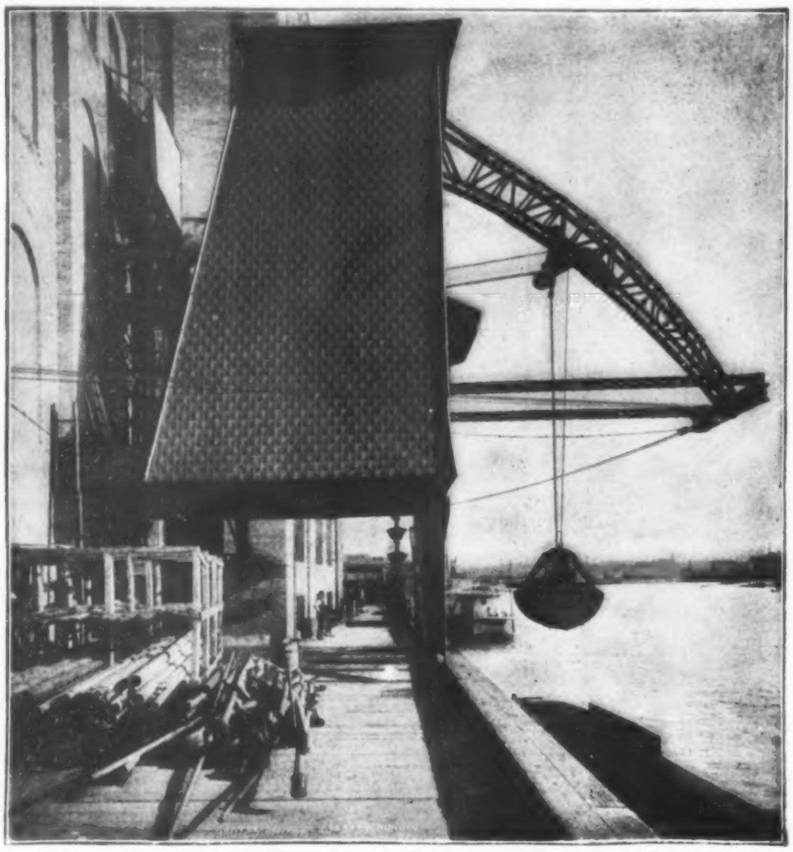


Fig. 2.—STEAM SHOVEL AND ELEVATOR FOR HANDLING COAL ON THE WHARF OF THE BROOKLYN HEIGHTS RAILROAD COMPANY.

One of the most exquisitely sensitive instruments ever devised has just been set up by a mechanical engineer of New York. This is known as the mirror-testing apparatus, and is designed to test and register the expansion or stretching of metals under heat or strain. This marvelous affair is capable of accurately measuring the strain caused by the footfall of a pedestrian crossing Brooklyn Bridge.

This instrument is exceedingly simple. Its chief part consists of a couple of little mirrors carried on spindles, which, in turn, are fastened to a pair of knife edges, so that the slightest change in the position of the knife edge causes a deflection of the mirrors. For the rest there is an ordinary reading telescope, to which is attached a finely graduated scale, reading down to 1-100,000 of an inch. These readings cannot, of course, be detected with the naked eye, but only through a strong telescope. Now, when the knife edges are lightly clamped against the object to be tested, say a bar of steel, and the latter be stretched or expanded, the knife edge will change position, the mirror will be deflected, and as the latter is looked at through the telescope from a distance of five or ten feet, the graduated scale which the mirror reflects seems to move up and down. And by watching these movements the stress on the bar is easily calculated.

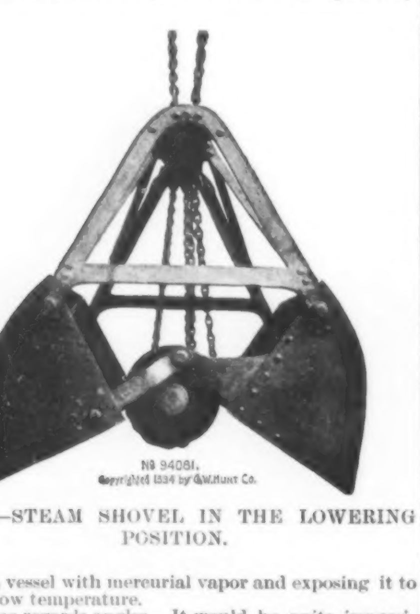


Fig. 3.—STEAM SHOVEL IN THE LOWERING POSITION.

Fig. 4.—STEAM SHOVEL IN THE HOISTING POSITION.

An instrument so sensitive as this, and dealing with graduations of 1-100,000 part of an inch, will register the most minute changes of temperature. The mere proximity of the body will, by the expansion due to the heat radiated therefrom, introduce errors, and in fact the utmost precaution must be taken in this regard to see that the temperature of the room in which the observations are to be made does not vary while they are in progress. Moreover, nervous or excitable persons cannot use such delicate micrometers at all, and even for others considerable experience is necessary before one can become expert in their use and their delicate readings be of practical value.

In the manufacture of such instruments as these, other instruments hardly less delicate and accurate are in turn required. Take what is known as a micrometer caliper, on which accurate measurements may be made to 1-10,000 of an inch. It is easy to see that the slightest inaccuracy in any one of its parts would throw all the others out of adjustment and destroy the value of the instrument. Expensive special machinery of almost perfect precision is necessarily required for this class of work, and the final testing of a caliper of the kind mentioned must be made with a standard scale. The latest development of this type of appliances is to be seen in the shops of a manufacturing company in Providence, R. I. On a massive bed, eighteen inches high, are two movable heads fitted to the broad flat surface and gibbed at the sides. The larger head carries a bar having a finely graduated scale, with markings down to 1-40 of an inch on the upper side and another on the lower side, so fine as to be invisible without the aid of a powerful glass. Over this latter scale is a microscope, fitted with a micrometer eye piece, for reading these fine graduations. The latter are read by means of a vernier scale, and their valuation is 0·00001 of an inch. The cone at the back of the machine is for the purpose of concentrating light upon the graduation of the scale.

The chief adjustment of the machine is by the manipulation of the hair lines of the microscope so that the latter are coincident with the lines of the scale. Thus, in taking a measurement, the machine is first adjusted to a point on the graduating scale corresponding to the nearest fortieth of an inch to the size to be measured. Intervals of less than this are obtained by means of the micrometer screw. Here, likewise, for fine readings, care must be taken to provide a constant temperature, since it seems impossible to construct an instrument of perfect compensation for the different rates of expansion of the various metals composing it.

ELECTRICITY FROM CARBON WITHOUT HEAT.*

By Willard E. Case.

The subject has such possibilities, all within reasonable bounds, that I hardly know where to commence or finish. At present we have only crossed the boundary line of that field which I am sure will be productive of tremendous results.

Thermo-electricity has attracted attention for a great many years past, and now and then we have heard of new inventions which led us to think that we were about to solve the problem.

As far back as 1801, Ritter noticed that a current was set up when the junctions of dissimilar metals were heated. And following down to a later date, we find that some thermo-electric batteries were constructed which really produced electrical energy at small cost, and which have been to some extent found practicable. A thermocell was described by the speaker before the Royal Society in 1886, which I will now show you. (Experiment shown.)

It consists of plates of tin and platinum, forming the electrodes, immersed in a solution of chromic chloride. When the cell is heated, the electrolyte becomes active; chlorine, leaving the chromic chloride, temporarily combines with the tin and forms proto-chloride of tin. This chemical action generates electricity, and soon the tin is all converted into chloride and the current ceases. When the cell is cooled this temporary combination of the chlorine and tin is broken up and the chlorine returns to chromium proto-chloride. The tin being set free falls as a metallic precipitate to the bottom of the cell in the form of crystals, ready to renew the operation. If this cell works between 80 and 180 degrees F. or 538 and 638 degrees absolute, the e. m. f. at the higher temperature is about 0·26 volt, but the possible efficiency is less than sixteen per cent., owing to the operation of the second law of thermo-dynamics, which provides that in the conversion of heat into work, the efficiency equals the higher temperature minus the lower temperature divided by the higher temperature reckoned from an absolute zero, the latter being minus 273 degrees Cent. So that this cell is a heat engine; a reversible voltaic cell which passes through a complete cycle. It must be heated to operate, and cooled to regenerate itself.

In this connection it may interest you to see in operation a more practical thermo-cell which converts heat into electrical energy. This battery is said to consume 2½ cubic feet of gas per hour, and to generate 12½ watts. (The Cox thermo-generator was shown in operation driving a fan.)

In order to make the subject clear to those who are not familiar with it, let me say that all electricity (except that produced by water power or galvanic batteries) is obtained from carbon. That is to say, our electric power of to-day is generated by the combustion of coal under the steam boiler, or by means of the gas engine, and through the intermediary of engines and dynamo this energy is converted into electricity. Now, we all know that this conversion of the potential energy of coal into heat and then into work is a most wasteful process, owing to the intervention of the second law of thermo-dynamics above referred to, and how to overcome this law and to avoid this waste is the subject under discussion to-night. Practically we only convert a small percentage of the potential energy of the coal into work, a large portion being wasted. It is not so much the inefficiency of the boilers or the steam engine or dynamo, which converts this energy into electricity, as it is the method adopted. When we burn coal under the boiler, we transform the energy of that coal into heat energy, and the moment we do this, we come in

* A lecture delivered before the New York Electrical Society, Feb. 24.

conflict, or rather become governed by, the second law of thermo-dynamics.

It is an inexorable law of nature that under the conditions in which we live, a great waste must accompany the transformation of heat into any other form of energy. To illustrate, in hot air and gas engines, a cold water jacket is usually employed, and to raising its temperature is diverted the larger share of the heat. In the thermopile, the junctures must be cooled by a circulation of air or water, and in Edison's pyromagnetic generator, the iron tubes must be cooled by application of cold air.

In accordance with the second law of thermo-dynamics, the heat not lost but which we can utilize in a given case equals the diffe ence between the high and low temperatures used, divided by the low temperature. Now, to express this more simply, there is heat or an expansive force in everything, down to an absolute zero; but under ordinary conditions, we cannot economically use this heat in any machine below the average normal temperature in which we live. So when once we set up molecular motion, called heat, we only use it above the normal temperature, up to that point to which we are limited by the destruction of matter. Or as we might say, to that point at which we burn out our boilers or melt our containing vessels. And this range is but a small fraction of the total range of the heat we have produced. Lodge has shown us that the energy in a pint of boiling water, if it could be all utilized, amounts to more than half a million foot pounds, and even if the water were quite cold, and on the point of freezing, it would still contain energy of 350,000 foot pounds of work, or ⅙ of a horse power hour in every pint. Now, coal or zinc could be burned to heat this water to a boiling point, in which case only a part of the energy between that point and freezing could be utilized, which is a small portion of the total range between the boiling point and absolute zero. But either material can be oxidized in a galvanic battery without heat and waste, and electricity produced. If we burn the coal, as Lodge has suggested, the highest temperature commonly available is that of the furnace; hence the heat should be supplied to the working substance in the cylinder at a furnace temperature. This condition is roughly satisfied in internal combustion engines, though they have many defects at present. This furnace temperature is about 2,000 degrees above absolute zero, or 1,500 degrees Fahr., and if in this engine we could cool down to 600 degrees above zero, or 110 degrees Fahr., we could have a possible efficiency of 70 per cent. of the whole, $\frac{2{,}000 - 600}{2{,}000} = 0{\cdot}70$, that is, 70 per cent., less the friction of the machine and the loss in the conversion into electrical energy, which would bring it down to something like a possible 50 per cent. or 60 per cent. The steam engine does not even approach this. Its theoretical efficiency at 300 pounds steam pressure is 33 per cent., but in actual operation this is reduced to 25 per cent. Gas engines, internal combustion engines, come nearer this ideal. In fact, Prof. Thurston states that a cannon when being fired has an efficiency of 50 per cent.*

FIG. 5.—CURVE IN THE CABLE RAILWAY OVER COAL POCKET OF FIFTY-SECOND STREET STATION, BROOKLYN HEIGHTS RAILROAD.

Let it be understood that this is a law of nature; it is inevitable under the conditions in which we live. No cunningly devised furnace or feed-water heater, or cut-off, or triple expansion apparatus, or pyrogenerator can save this heat. The most that any of these devices can do is to save what would otherwise be wasted, over and above that which we must of necessity lose.

Now, the question which we naturally ask is: How are we to convert this potential energy of the carbon into electricity with the least loss?

If the boiler, steam engine and dynamo are not available for our use economically, how shall we do it? We know that the voltaic battery does not act through the transformation of heat into electricity; it produces electrical energy direct. The zinc is oxidized and the potential energy of that zinc is converted directly into electrical energy, without the production of heat. The second law of thermo-dynamics is thus avoided as no heat appears. But, the cost of this zinc and the chemicals employed to oxidize it are so expensive that we cannot afford to use them. The cheapest materials which present themselves at present to our notice are coal or carbon and the oxygen of the air. And if we could convert the energy of the coal into electrical energy direct and cheaply, we could do away with our steam motors, in time, provided the apparatus was simple and practical. Now, there is no known reason why a cheap substance may not yet be found which will act on coal and develop electrical currents in place of heat, but the general tendency of late has been to discard this method and to attempt to find some stable electrolyte or bath, which will act as a carrier of the oxygen of the air, conveying it to the carbon and oxidizing it, as zinc is oxidized in a battery, producing electricity. This electrical energy would be the equivalent of the heat energy that would be developed by the combustion of the coal in the ordinary way.

FIG. 6.—CABLE RAILWAY FROM THE WHARF TO THE COAL POCKETS, FIFTY-SECOND STREET STATION, BROOKLYN HEIGHTS RAILROAD.

Of course in the construction of such a cell we must be governed by the experience which we have had with the galvanic battery in which the elements of electromotive force, internal resistance, etc., are involved and by which consequently the output of the cell is governed; such a cell must produce a large amount of energy, be simple and easily cleaned or recharged, in order to be practical. It must be as durable and as simple to use and handle as the steam boiler and dynamo are to-day.

It may be of interest to give you a comparative illustration of what the energy of coal does to-day through the use of the steam engine and what it would do provided we could oxidize it in a battery without heat. The average of large electric light plants requires 4 pounds of coal for every horse power hour of electricity delivered from the dynamos to the line. That is to say, four large stations show a consumption of 4·2 pounds per horse power hour; forty-nine stations, 4·6 per horse power hour; and thirty-two small stations, 12 pounds per horse power hour. Theoretically, 0·175 pound of coal will yield one horse power hour, or, allowing for ash, 0·185 pound; and of zinc, one pound used in a battery produces one horse power hour under a potential of two volts, including the loss in internal resistance. The cubes of these materials represent the weights required by each to produce one electrical horse power hour. (Experiment shown.)

Of course, the subject of electricity direct from carbon has been considered from many points of view. Some have attempted to obtain cheap electricity by using the oxygen of the air to oxidize various substances; others have attempted to oxidize coal with the oxygen of the air without heat, and others have attempted to oxidize coal by the oxygen of the air with the application of external heat. The evolution of this subject is most interesting. We will, therefore, study the question from that point of view, and examine some of the most important batteries which have been constructed. We will do so chronologically. Of course, lack of time will compel me to avoid reference to many well conceived inventions.

Passing over the carbon-consuming cells of Jablochkoff, Bard, Crumm, Edison, Wright and Thompson, I will first describe the cell invented by C. S. Bradley in co-operation with Prof. F. B. Crocker, which was mentioned in the discussion of a paper read by the speaker on "Electricity from Carbon Without Heat," in 1888, before the American Institute of Electrical Engineers.

Mr. Bradley described fully the action of fused salts on coal, and stated that the oxygen of the air was absolutely necessary for the purpose of cheap oxidation, or, to use his own language, "The cell consisted of fused sodium manganate, and putting a blast of air through it, and by that means supplying it with oxygen and allowing it to act on the coal which is put in another part of the vessel, a little over one volt was obtained."

The cell consists of an iron vessel 2½ in. in diameter and 6 in. deep, which is placed inside of a retort and heated by a gas flame to nearly a red heat. The electrolyte of the cell is caustic soda, to which peroxide of manganese is added, forming sodium manganate. In this cell is immersed the electrode of carbon, which acts as the positive pole, and when the circuit is closed you will see that we will have an electromotive force of about one volt with a current of three amperes. (Experiment shown.)

The next cell to which I will ask your attention is that described by W. W. Jacques in Harper's New Monthly Magazine in December, 1896, which is another illustration of the same principle involved in the Bradley cell, with a few practical modifications. It, like the other cell, consists of an iron vessel, which is the negative electrode, containing fused caustic soda, minus the peroxide of manganese, into which is plunged the positive coal or carbon. The oxygen is supplied by a blast of air, as in the cell before described, and an e. m. f. of about one volt is said to be obtained. The difference between these two cells, which I particularly desire you to notice, and the only practical difference between them, is the addition of peroxide of manganese to the bath of the Bradley cell, and although I have described them chronologically, I will first show the Jacques cell and then by simply adding peroxide of manganese to it we will have the Bradley cell. We will then be enabled to get their comparative e. m. f. and current in the same cell. But I may say in passing that experience with these cells before you leads me to believe that the theory of their action is not by any means well understood. It is most uncertain and erratic, and seems to be more so before than after the addition of the manganese peroxide. For instance, its e. m. f. seems to depend upon its temperature. If water is present when the caustic soda is first used, a reverse current becomes manifest. When air is blown through the electrolyte, the e. m. f. is increased. Sometimes only 0·3 of a volt is obtained; sometimes about 1½ volts. But the greatest amount of current is apparent when the carbon is immersed in the bath.

When the carbon rod is drawn up along the inside of the vessel, the highest e. m. f. is obtained, and when this carbon electrode is replaced by another having none of the fused electrolyte on it, and brought in contact with the exterior of the vessel at different points where the temperature varies, no appreciable e. m. f. is obtained. This would indicate that as we drew the carbon up out of the bath against the side of the vessel we approach a point where the critical temperature exists and we get the highest e. m. f.

If a nickel crucible be used as suggested by Bradley some years ago, the e. m. f. is brought up to what is considered the theoretical, as you will see. This little nickel crucible contains fused caustic soda and carbon electrode, the same as in the Jacques cell. When heat is applied, you will notice that the voltage goes to 1·16, then begins to fail, and at a critical temperature above a red heat, it drops to 0·3 volt, a most interesting fact, and on cooling the voltage goes up again to 1·16 and drops again when the caustic soda solidifies. You will observe that the voltage is above the theoretical. (Experiment shown.) Many other peculiar actions will be noticed if the carbon rod is replaced by an iron one. With this form of cell it is claimed that as high as 85 per cent. of the energy of the carbon consumed is con-

* Science, October 3, 1891.

verted into electrical energy. The following results of tests of the Jacques cell taken from the article referred to and from the Engineering Magazine of July, 1896, may be of interest. Electricity obtained from 1 pound of coal (of which 0·4 pound was consumed in the pots and 0·6 pound was burned on the grate) equaled 1,336 watt hours, or 32 per cent. of that theoretically obtainable.

Another cell reported in the public prints to have been built and operated by Jacques consisted of 100 iron cells 1½ in. in diameter and 12 in. deep, which gave an e. m. f. of about 90 volts and 16 amperes, supplying thirty 16 candle power incandescent lamps for a little over 18 hours. In this experiment it is said that about 8 pounds of carbon were consumed in the cells. This, it was stated, gave an efficiency of over 90 per cent., which, of course, did not include the power to operate the air pump and the coal consumed in heating the cells. But my experience with the cells before you leads me to doubt the correctness of these computations.

It has been suggested that carbon-consuming batteries would be too bulky and occupy too much space as compared with that occupied by the present central station for a given output. I find, however, that the Edison station at Duane Street has a capacity of 28,000 electric horse power. The cubical capacity of the building is in round numbers 900,000 cu. ft. The same building crowded with Jacques cells, assuming that they would perform the work claimed for them and leaving aside the question of the difficulty of their operation, properly distributed, would have an output of 60,000 horse power. This estimate is necessarily theoretical and based entirely upon statements made by Mr. Jacques, namely, that a furnace containing cells occupying a cubical space of 600 ft. has a capacity of 40 electrical horse power. You will thus see that this ratio is in the proportion of 28 to 60 in favor of the battery. It has been stated that the e. m. f. of the carbon-consuming cells is so low that they would be of no practical value. I think our experience with the storage battery in central stations refutes this idea, at least for potentials up to 250 volts, and by means of rotary transformers the current can, if necessary, be converted into any form and pressure.

These cells, if correct in theory, can be heated without infringing on the second law of thermo-dynamics, as the law does not apply so long as the oxidization of the carbon itself does not produce heat, but electricity. For, as we have said, there is heat in the electrolytes and all matter down to an absolute zero, and the electrolyte in the practical operation of these cells is simply heated to permit the chemical affinities acting. We are governed here, as elsewhere, by the laws of evolution, and I think that this question will be solved only through many attempts and many failures. I believe that we must look at this subject from a different point. In the first place, can we not learn a lesson from nature? We certainly have a most wonderful example of the conversion of potential energy of carbon direct into work in the animal economy, which is developed at the expense of the oxidization of the material supplied by the food, with an efficiency twice as economical as in the case of the steam engine. One-fifth of the potential energy is converted into work; four-fifths is converted into heat. But we must remember that the human body must be able to exist in the Arctic regions as well as in the tropics, that the engine room must always be kept warm, and to insure this average temperature in all parts of the earth and under all conditions, the four-fifths of what apparently is waste energy is necessary to maintain the race.

A day's work of muscular toil is laid down by the authorities at about 1,084,950 foot pounds. The normal daily expenditure in heat cannot be so readily determined; it is estimated at 6,148,000 foot pounds; that is, between one-fifth and one-sixth of the potential energy of the food is expended as mechanical labor; the remaining four-fifths or five-sixths leaves the body in the form of heat. Of course eventually the work goes into heat and is dissipated.

In the human economy the oxygen of the air is taken up by the blood in the lungs. It is carried through the arteries and attacks the tissues, giving up its oxygen and so oxidizing them, and thus producing heat, and when work is done, the equivalent of the heat disappears as work, and when the work is not done the temperature rises, perspiration and evaporation take place and the temperature is kept at its normal condition through this safety valve. In other words, expressed electrically, there is local action as in a battery. I am aware that the question of the cause of muscular contraction is in dispute, but it is generally admitted that the muscular force must be derived from chemical energy.*

Observe, in the first place, that nature prepares the food which it consumes to perform its functions. The food is taken into the stomach and digested. A great part of it is useless, the best part is selected and is transformed into a condition in which it can be easily oxidized at a low temperature, the blood acting as the carrier of the oxygen. Does this not give us a hint that we should follow this course likewise and prepare the material for our carbon-consuming batteries? The oxygen of the air we always have with us; so have we many carriers of oxygen, but an attempt, so far as I know, has not yet been made along this line which I suggest, except that illuminating and other gases have been used.

A cell which I will soon show you is one described by me in a paper read before the American Institute of Electrical Engineers in 1887. It consists of two electrodes, one of carbon, surrounded by powdered carbon, in a porous cup, and one of platinum, both being immersed in an electrolyte of sulphuric acid in a glass jar about one inch in diameter and six inches in height. Into this electrolyte when we introduce chlorate of potash we form peroxide of chlorine, which is a very unstable gas and decomposes in the presence of carbon; its oxygen attacking the carbon oxidizes it without heat, the chlorine being set free at the platinum pole, electricity is generated with an electromotive force of 1·3 volt, varying with the amount of oxidizing agent present and with the kind of carbon used. Or, we can place these two electrodes in a vessel containing water, generating this gas outside the cell and pass it over into the cell containing the electrodes, in which case the cell will operate the same as before, its internal resistance being regulated by the amount of sulphuric acid we may wish to add to the water.

* Proceedings Royal Society, March 12, 1895.

You will notice that when the electrodes are immersed in the sulphuric acid that only a slight e. m. f. is indicated, due to the combination; on the addition of chlorate of potash, the e. m. f. is about 1·3 volts per cell and the current about 0·4 of an ampere. To show you that the action is strong and the oxidization of carbon rapid, I will connect the cell with this little electric bell, which will give you an idea of its strength. (Experiment shown.)

We have been taught to believe that the e. m. f., due to the oxidization of carbon, is about 1·05 volts. This value has been arrived at by assuming Andrews' determination that the oxidization of one pound of carbon to CO_2 equals 14,544 B. T. U., or that one gramme equals 24,944 foot pounds. This determination was only approximate, and, further, it was a determination made at a very high temperature. Now you have seen that the oxidation of carbon in this cell without heat has produced 1·3 volts, and would produce even more if we chose to concentrate the peroxide of chlorine present, which is rather a dangerous operation, as the gas is an explosive one under some conditions. So it would apparently appear that there are more foot pounds of energy in a pound of carbon than shown by Andrews, unless the additional energy in this instance comes from the peroxide of chlorine.

It might be thought that the high e. m. f. obtained in this cell is due to the action of the nascent chlorine on the platinum, but careful measurements have determined the contrary.

We have here, therefore, a cell in which carbon is oxidized without the application of heat and at normal temperatures; a cell in which oxygen in unstable composition is readily given up to the carbon and the product of the oxidization is carbonic acid gas, as proved by analysis. I think we have, therefore, the right to assume that a large percentage of the potential energy of the carbon is converted into electrical energy. The point I wish to make in this connection is: We have in this cell conditions which are analogous to those taking place in the human system, at least to the extent that carbon is and can be oxidized at the normal temperatures under which we live, and its potential energy converted into electricity.

We have in the blood of the human economy a carrier of oxygen, called hæmoglobin; it absorbs its oxygen through the lungs, each gramme taking up 1·34 c. c. of oxygen; this oxygen is in such unstable condition that it can be extracted from the blood by means of a vacuum and by means of most reducing agents; yet it has the power to oxidize carbon and hydrocarbons as the body provides them, without external heat.

We have in this test tube, water containing hæmoglobin in solution. You will see that by transmitted light it is of the color of arterial blood, as it is fully oxidized, and when a reducing agent is added to it, and the air excluded, you will see that it becomes the color of venous blood, and when the air is again admitted, it takes up the oxygen and becomes arterial in color. This game can be played, of give and take and oxidizing and deoxidizing, as many times as we like. Even carbon reduces it and gives an e. m. f. (Experiment shown.)

What I want to express to you is this: In this battery which I have just shown you, carbon is completely oxidized at normal temperature by oxygen which is held in loose combination. So it is done in the human body, and we know that to be a very efficient machine. Therefore I see no reason to think that it is necessary for us to use high temperatures. Keep without the second law of thermo-dynamics; search for a suitable carrier of oxygen or some cheap source of oxygen supply and hydrogen or carbon; or a carbon compound easily oxidized.

Does it not seem logical that by following along this line and by preparing the material to be consumed, as nature does in the human body, we may yet be able to reach the desired end with economy? Is it not probable, judging from human experience, that within the wide range of materials, some cheap means can be found? I believe it is. Like all good things in nature, it will come through many trials and failures. The struggle for existence will perfect it, but there is no known law which indicates that we are dealing with the impossible.

METALLURGICAL APPLICATIONS OF ELECTRIC HEATING.

ELECTRO-HYDROTHERMIC PROCESS.—Three Belgian engineers, Messrs. Lagrange, Hoho and Julien, entirely abandoning the methods recommended by Messrs. De Benardos and Thomson, devised in 1893 what was called by them a new electro-hydrothermic process, based upon the use of electrolysis. When the poles of an electric source are immersed in acidulated water, a decomposition of the water occurs, the oxygen goes to the anode (a plate of lead) and the hydrogen to the cathode (a bar of iron), and the production of the gas may become such that the entire bar of iron will become covered with a gaseous coating that offers considerable resistance to the passage of the current. The heating of the bar that results therefrom is such that a temperature of 4,000° has been easily reached in certain experiments. It will be conceived that, by limiting the temperature to between 800° and 1,200°, it will be possible to forge and even to easily weld the piece that constitutes the cathode. To this effect, it suffices to properly regulate the ratio of the two surfaces of the poles, the positive anode being formed of a wide sheet of lead lining the interior of the glass or porcelain vessel. The piece to be heated is immersed to a greater or less depth, and this permits, if need be, to localize the heat at the point desired in covering the parts that are to remain cold with an isolating envelope of the liquid. For the convenience of maneuvering, a flexible conductor, ending at the positive pole of the electric source, leads the current to a double iron clamp, with an insulating sleeve that carries the bar to be operated upon.

This system presents over former processes the great advantage of requiring, for welding, currents of but from 100 to 200 volts, exempt from great danger in the application and capable, nevertheless, of being utilized for working bars of iron of 1¼ inch thickness. With a current intensity equal to 220 amperes and 120 volts, the inventors have obtained at Berlin the formation of graphite (4,000° C.) in employing a rod of carbon at the pole. They calculate in this way to convert into heat fifty per cent. of the energy expended in the production of the electricity, while previous processes seem to render scarcely more than twenty per cent. It is thus possible, at will, to produce heat in a neutral medium, oxidizing or reducing. Finally, it is possible to effect the tempering of metals by heating them in the very liquid medium that is designed to harden them, and, in this way, to obtain an artificial tempering.

Through the fusion of the cathode, the surface laid bare is perfectly clean, and free from sulphur and all those impurities that are so difficult to eliminate by fire in the ordinary forge. There is no oxidation to be feared in this reducing envelope of hydrogen.

THE G. D. BURTON PROCESS.—This inventor likewise treats ores that are melted through the addition of a special flux. The gangue constitutes the resistant envelope that raises the temperature of the mixture, and the less fusible the ore is, the less intense the current has to be. Every metal abandons the gangue as soon as it has reached the temperature of fusion characteristic of it. Thus, in ore containing lead, copper, gold and silver, the lead is observed to separate almost immediately, and then the silver and the copper, and finally the gold, the gangue being at length disintegrated and reduced to dust.

In a single operation lasting from thirty-five to forty minutes, it is possible to heat a ton of California ore containing from twenty to thirty per cent. of inert material, and placed in a refractory furnace. The necessary energy, say 2,000 amperes at 250 volts, is easily obtained in situ and very cheaply in this country, where waterfalls abound, while, by the old chemical methods, the carriage of the ore, which was as costly as the smelting itself, greatly increased the expenses of the exploitation.

In Canada, the same process has furnished excellent results in the treatment of the ores of nickel.

ELECTRIC FURNACES.—These electro-chemical methods very naturally lead us to speak of electric furnaces. The original idea of these is very simple. The ore playing in the interior of the furnace heats, either directly or by simple radiation, the substances that have previously been placed therein—say bars, rods, wire, etc. It is by means of these furnaces that it has become possible to reproduce artificially the natural conversion of carbon into graphite.

The Faure furnace (Fig. 1) consisted at first of a vertical tube in which the materials were previously heated

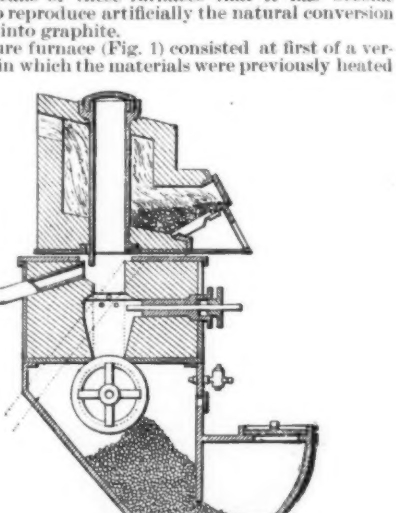


FIG. 1.—THE FAURE ELECTRIC FURNACE.

by an external fire. They afteward descended into a compartment wherein they were submitted to the high temperature of an electric arc playing between two electrodes. The metal obtained was received by means of a lateral tubulure, and the residua of the operation were expelled automatically through the bottom.

Toward the same epoch, Inventor Bradley took out patents for the arrangement shown in Fig. 2. The electric current alone fuses a portion of the material to be treated, and afterward finishes the decomposition of

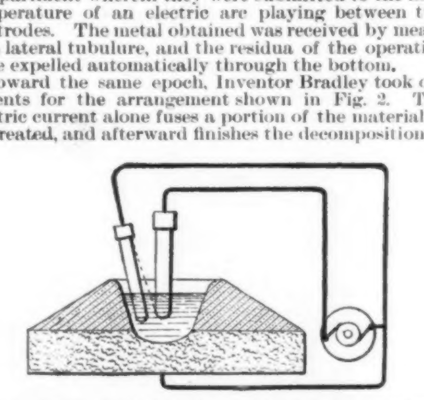


FIG. 2.—THE BRADLEY ELECTRIC FURNACE.

the rest under protection from the liquid envelope thus obtained. The inventor specifies that it is possible for a blowpipe, conjointly with an electric current, to furnish a part of the heat necessary, according to the principle adopted by Faure and described above.

In 1885–86 appeared the Cowles process, which, by its ingenious simplicity, attracted the attention of the scientific world as well as that of the industrial. It, unfortunately, did not realize all the hopes that were manifested at its debut, and particularly for the treatment of aluminum, which can now be produced by more advantageous methods. This process consisted in mixing the ore to be reduced with a substance, such as carbon, that offered great resistance to the passage of the current (Figs. 3 and 4). The high temperature that resulted therefrom brought about the reduction of the oxides that had been most refractory up to then—such as silica, potassa, soda, lime, and the oxides of chromium, titanium and even of aluminum.

But, in this latter case, in order to prevent a combination of the carbon with the aluminum, it became necessary to introduce into the mass a metal capable of giving an alloy of aluminum, say copper, for example. The production of the very intense heat in this brick furnace was attributed not only to the artificial resistance opposed to the passage of the electric current, but especially to the fact that between all the particles of

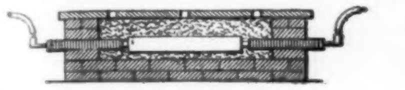


FIG. 3.

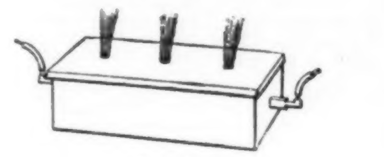


FIG. 4.

THE COWLES FURNACE.

the resistant mass there must have played an infinite number of small local arcs, each capable of reducing the materials in direct contact with it, thus permitting of obtaining very homogeneous products of final composition.

Again, let us mention the arrangement patented in 1881 by Ball and Guest for an electric furnace designed for the manufacture of carbons for electric lighting (Fig. 5). The prepared carbons are piled up between

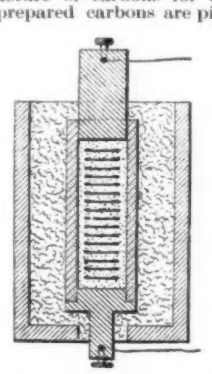


FIG. 5.—THE BALL & GUEST FURNACE

two walls of carbon connected with the electrodes, and the crucible itself is filled with powdered charcoal. Here again the heat obtained is due to the resistance created by the surrounding mass.

In order to understand the mode of action of the current in each of these applications, it is well to analyze the transformations of energy that occur. We borrow from Mr. Perrodil the very clear principle of a distinction between electrolytic electric furnaces, in which electrolysis by dry way or by wet way is the base of the process, and electrothermic electric furnaces, in which electricity is used solely for the production of heat.

A current of an intensity, I, in traversing for t seconds a circuit of a resistance, R, produces a heat equal to $t \times R \times I^2 \times 0{\cdot}24$ heat unit, that is to say, that the heating is proportional to the square of the intensity, and has for a limit only the temperature of vaporization of the substance of which the circuit is composed.

In the electric furnaces previously described, the materials in reaction are placed in the arc itself, either because the crucible forms one of the electrodes and the current traverses the mass to be fused, or because there is introduced a graphite core in the midst of the materials to be combined. It becomes very difficult to separate the electrolytic from the calorific actions of the current.

On the contrary, in true electric furnaces, which we shall here call electrothermic, because the entire elec-

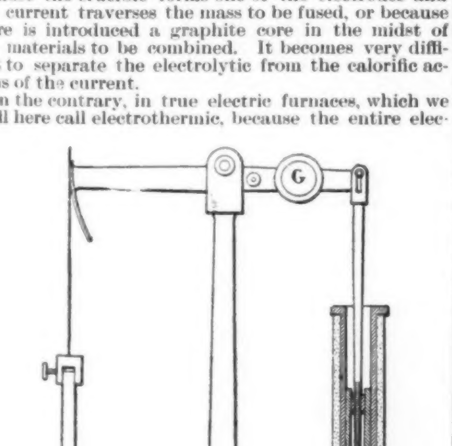


FIG. 6.—THE SIEMENS FURNACE.

tric energy is converted therein into thermic energy, the materials to be heated are placed outside of the arc, in order to be submitted to the elevated temperature of the latter. If the mixture is placed in the arc, the fusion at the beginning produces a cavity in which the arc plays, and the heat produced by the latter fuses the surrounding parts. According to Mr. Violle, the maximum temperature that can be reached thus (which is that of the vaporization of the carbon of the electrodes) is about 3,500°.

THE SIEMENS FURNACE.—A crucible, a (Fig. 6), of plumbago, is placed in a metallic receptacle, and the space, b, which remains free, is filled with a material of slight conductivity. The perforated bottom receives the positive electrode, c, of dense carbon. The cover of the crucible, which likewise is perforated, carries the negative electrode, which consists of a large cylinder of compressed carbon.

By means of a strip of copper, or of some other good conducting material, the negative electrode is suspended from the extremity of a beam at the other extremity of which there is a hollow cylinder of soft iron capable of sliding in the interior of a solenoid of fifty ohms resistance. By means of a counterpoise, G, is counterbalanced the magnetic force with which the hollow iron cylinder is attracted in the solenoid, and it is thus possible to fix the resistance of the arc.

The automatic regulation of the latter is essential for the proper results of the electro fusion. Without that, the resistance of the arc would rapidly diminish with the increase of the temperature of the atmosphere of the crucible, and heat would be developed in the machine that generates the current.

THE SLAVIANOFF ARRANGEMENT.—Mr. Nicolas Slavianoff, a Russian engineer, effects the automatic regulation of the arc by means of the arrangement shown in detail in Fig. 7, and, as a whole, in Figs. 8 and 9.

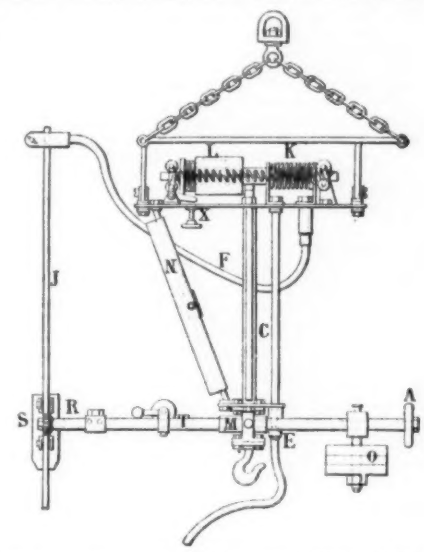


FIG. 7.—THE SLAVIANOFF AUTOMATIC REGULATOR.

The automatic regulator is inclosed in a metallic box supported by two chains with hooks. It comprises a double solenoid, LK (Fig. 7), in the interior of which a core carried by rollers is capable of moving.

This core is connected with a lever, C, that carries at its lower end a sleeve, M, in which revolves the axis, T, under the action of a small hand wheel, A. This latter actuates an indented roller, S, which causes the fusible electrode, J, guided by the wheel, R, to rise or descend.

On each side of the solenoids, K and L, there is a

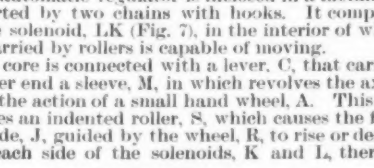


FIG. 8.—THE SLAVIANOFF FURNACE COMPLETE.

spiral spring that may be loosened or compressed by means of a lever and the screw, X. This spring counteracts the action of the solenoid and is designed to limit the too great sensitiveness of the apparatus. This is rendered necessary by reason of the abrupt variations of the current under the influence of the drops of molten metal that constantly interpose themselves between the two poles. A similar effect is obtained by

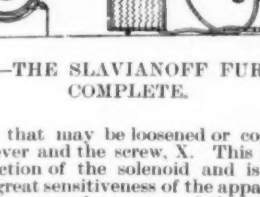


FIG. 9.—INSTALLATION OF THE SLAVIANOFF REGULATOR.

displacing the movable counterpoise, O, along the axis, T. At N there is a frame with colored glass for protecting the eyes of the workmen against the light of the arc.

The current reaches the solenoids through the flexible cable, E, and after traversing them, passes through the cable, F, and the electrode, J, and finally returns through the other electrode to the generating dynamo.

For operating, the electrode bar is brought within ten or twelve inches of the mould and the handwheel, A, is then revolved so as to bring the poles into contact. The regulator then operates, the electrodes separate, and the arc plays. It then suffices to cause the electrode, J, to descend, through the handwheel, A, in measure as it fuses. The action of the solenoids immediately compensates for the small error committed.

The capital point of the invention is that, thanks to the automatic regulator, the accumulators of the Benardos process are suppressed. Fig. 8, which represents the Slavianoff installation in its entirety, shows that the current is taken directly from the dynamo in interposing in the circuit a voltameter—a variable resistance composed of several groups of spirals coupled diversely upon a German silver frame, and, finally, a pole reverser designed to compensate for the inequality of the heat disengaged at each pole, and which at the positive pole is about double that which is produced at the negative one.

At the works of J. Pintsch, of Berlin, the dynamo employed, which is of the Fritsche continuous current system, gives 120 revolutions at a maximum of 600 amperes and 70 volts. The intensity necessary is from 7·5 to 8 amperes at an average of 60 volts, per square millimeter of the bars operated upon.

THE MOISSAN FURNACE.—The true electric furnace, the one that has given the most constant and remarkable results up to the present, is due to Mr. Moissan (Fig. 10).

It consists of two slabs of lime well dressed and placed one on top of the other. The lower one is provided with a longitudinal groove that receives the two elec-

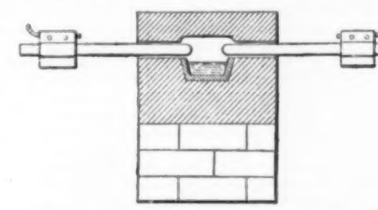


FIG. 10.—THE MOISSAN FURNACE.

trodes, and in the center there is a cavity that serves as a crucible. This cavity, which may vary in depth, contains a layer of the substance upon which the calorific action of the arc is to be directed. It is possible, also, to place therein a small carbon crucible containing the material that is be calcined. The upper slab is slightly hollowed out at the part above the arc.

The arc causes the fusion of the surface of the lime in giving it a beautiful polish, and in thus forming a dome that reflects the entire heat upon the small cavity containing the crucible. It will be seen that the material to be treated is not in contact with the electric arc, that is to say, with the vapor of carbon. It is, moreover, a reverberatory electric furnace, with electrodes rendered movable by means of two supports. Electrolytic actions are completely eliminated. They do not intervene in the reactions, and impurities created thereby cannot be produced. The heat alone acts, and, as this is very elevated, it permits of obtaining reactions that it has been impossible to produce up to the present.

This furnace in particular has permitted of the manufacture of fused carbide of calcium, pure and crystallized. It has been the starting point of the industrial furnaces created with a view to the preparation of carbide of calcium for acetylene gas.—H. Poisson, in Revue Industrielle.

BORON BRONZE.

By H. N. WARREN, Research Analyst.

THIS alloy—or, more correctly speaking, aluminum boron bronze—is brought about by the introduction of aluminum containing boron, not as aluminum boride, but existing as graphite does in cast iron. Commercially this part of the process is accomplished by heating, in a specially constructed oxyhydrogen furnace, an admixture of fluorspar and vitrified boric anhydride, until the dense fumes of boron fluoride commence to appear. At this stage ingots of aluminum are introduced into the liquid mass; reduction at once takes place, with the formation of free boron, which dissolves in the aluminum, rendering it crystalline and somewhat brittle. When this so prepared aluminum is alloyed with copper to the extent of from 5 to 10 per cent. a bronze is obtained, denser and more durable than ordinary aluminum bronze, and free from brittleness; but the most important property of the alloy is the readiness with which it melts and casts, whereas in the manufacture of aluminum bronze one of the greatest difficulties is to insure a uniform mixture. Often a very difficultly fusible alloy of copper and aluminum is formed upon the surface of the already liquid portion, and accompanied by superficial oxidation, thus obstinately refusing to alloy with the remainder. But in the case of the boron compound no such difficulties are met with, the alloy melting perfectly at a lower temperature than when employing pure aluminum. Boron, in fact, seems to have been but little studied, but it is evidently not so serious an enemy to cope with as its halogen silicon, which, when present in minute percentages only, determines the total ruin of the bronze with which it alloys; in other words, it stands almost entirely opposite to other elements, entering into the formation and forming compounds with the most refractory minerals with the greatest ease; for instance, borides of iron, manganese, nickel, cobalt, etc., may be readily formed by the reduction of their accompanying borates in the presence of carbon, while those of silver, gold, etc., can only be formed by the introduction of elementary boron into the fused mass; borides of the alkali metals, and even barium and calcium, have been obtained, but boride of mercury still remains unknown.—Chemical News.

WE regret that in our issue of February 13, 1897, we omitted to state that the article by M. Kauffmann, on the "Principal Serpents of France," was from Le Monde Moderne, to which journal we beg to make our acknowledgments.

ENGINEERING NOTES.

Of the 390 vessels under construction in the United Kingdom on December 31 last, 343 were steamships and 47 sailing ships, the respective gross tonnages being 755,975 and 28,736. As compared with the same date in 1895, these figures show an increase of 77,657 tons for steam and a decrease of 5,508 tons for sailing vessels.

As regards the material employed for the construction of vessels during 1896, of the steam tonnage, 99·3 per cent. was built of steel and 0·65 per cent. of iron. The iron steam tonnage is practically made up of trawlers, and comprises no vessel of more than 212 tons. Of the sailing tonnage, 96·2 per cent. has been built of steel and 3·2 per cent. of wood.

A deep water harbor at Mazatlan, on the west coast of Mexico, is to be provided by the Mexican government through a contract lately made with O'Connor & Smoot, of Galveston, Tex. Mazatlan has from 15,000 to 20,000 inhabitants and is the center of a country rich in mineral and agricultural resources. Surveys for the harbor are to be made jointly by the government and the contractors, and the estimated cost of the improvement is between $15,000,000 and $20,000,000 Mexican money. Col. A. T. Wrotnowski, M. Am. Soc. C. E., and director of harbor works at Vera Cruz, is said to be reporting on the feasibility of constructing deep harbors at Altata and Culiacan, the former place being the best western terminus for the Occidental Railway.

Engineering achievements and possibilities, from the modern point of view, are receiving an additional illustration in the case of the projected tunnel between the mainland of Italy and the island of Sicily, plans and details of which, in model, as executed by the Italian civil engineer De Johannis, have attracted much attention at the University of Padua. The principle employed in this project is described as that of boring in parabolic spiral lines. After thorough and careful studies of the Strait of Messina, its varying depths, the nature of the ground, and of all other conditions which might assist or interfere with such an undertaking, De Johannis decided that the beginning of the tunnel should be near San Giovanni di Sanitello, at the foot of the Aspromonte Mountain range, the mouth on the other side to be located on the Degli Inglesi plain. The entire tunnel will be nearly two miles long, and will consist in the main of two shafts of about 10,000 feet each, descending at a grade not exceeding 32 feet in each 1,000. Such a tunnel is thought preferable to a bridge that would involve such a great span and wind exposure.

In the matter of high or low grade coal for engineering purposes, Mr. C. F. White, in a paper communicated to the Western Society of Engineers, has a pointed reference to the statement not uncommonly made by steam users, viz., that the cheapest coal they can get gives them the smallest fuel bills—an equally common statement, however, being also made by those working steam plants being that there is really no profit in using cheap coal. Mr. White quotes from a high source the statement that, after several hundred careful boiler trials, the results showed that the price of the steam varied with the price of the coal, so long as the coal is burned intelligently. Where, then, several coals of different evaporative values and different prices are to be compared, a convenient unit of comparison is the cost of evaporating one ton—2,000 pounds—of water, since this can be had by simple division of the price in cents by the evaporation in pounds of water per pound of coal, from and at 212 degrees, the result of this comparison or calculation being the fuel cost in cents. Briefly, it is relatively expensive to burn a coal of high grade and price where the conditions do not preclude the use of a poor coal.

Innumerable are the substances besides leather which are employed in the manufacture of belting for the transmission of power; and, although the idea of using paper for belting is not altogether new, it may be interesting to many to know that the manager of a paper factory in Wurtemberg has actually begun the manufacture of machinery belting of which paper forms the chief ingredient. A French contemporary says that this belting is formed of tubes of paper strongly compressed and united into strapping by means of threads. The paper of which it is formed is composed of manila hemp fiber and of several chemical products not named. The finished belting is fortified against fluctuations of temperature, abrasion, and against slipping on the pulleys and stretching, by a coating or layer of special material into which it is plunged. The ends can be united in the manner usual with leather belting. Nothing is said as to the comparative strength of these paper straps nor as to their durability. These are considerations of the first importance; and, although it may be quite possible to manufacture belting of paper, we are more than doubtful if such material will have sufficient elasticity or toughness enough to bear the strain and rough treatment to which all kinds of machinery strapping is subjected.

The Great Western Railway Company is about to rebuild its Windsor station, at a cost of about $300,000, says The Engineer. This will be done in some sort as a means of commemorating the sixtieth year of Her Majesty's reign, and the chief features of the new building will consequently be an apartment to be known as the Queen's room, and a suite of rooms for the accommodation of royal and distinguished guests of Her Majesty on reaching or leaving Windsor. There are at present two platforms at the Great Western station at Windsor. In the new station there will be three, enabling the officials to deal with four trains at a time, instead of two, the limit of their existing power. In the rear of the Queen's room there will be a covered way, with an 80 foot curved roof, and the public approach to the station from Thamer Street will have a circular roof of generous span. The elevation will be in red brick and Bath stone, in a style which may be termed the Victorian Renaissance, while the Queen's room will be of Bath stone. It will be fitted internally with teak and will have a handsome glass dome. Although it will not be possible to have the station ready for the forthcoming celebrations, the Queen's room will be completed by then. The contracts for the works are already let, and they will be proceeded with immediately.

ELECTRICAL NOTES.

The depreciation of storage batteries is generally put down at 10 per cent. per annum. Mr. Charles F. Brush, of Cleveland, however, has had a large number in use for nine years and yet they show no signs of giving out.

A series of alarming explosions occurred on the Grande Place, Brussels, and in the neighboring streets recently, by which considerable damage was done to the roadways. The explosions appear to have been caused by the short circuiting of the electric underground cables igniting a mixture of illuminating gas and air in the mains.

The smallest electric light is the pea lamp. Its bulb is about $\frac{1}{4}$ of an inch in diameter, and physicians use it to illuminate the interior of the human body. Its carbon filament is but 2-1,000 of an inch in diameter and but $\frac{1}{8}$ of an inch long. This is but the 320th part of the volume of a 16 candle power filament, and it is asserted that it would take 44,800,000 of these to make a pound.

The distribution of electricity for the government electric lighting of Malta is effected by low tension alternating currents. Transformers fed by high tension feeders running from the generating station to various points in the towns supply this low tension system. This arrangement, says the Electrical Engineer, was adopted, in the first place, because it gives absolute safety to the users of the current; and, secondly, because it is possible to send the current through long feeders with only slight loss of power.

Of the total expenditure for the last half year's working of the Liverpool Overhead Railway some 23·4 per cent., representing 3·6 d. per train mile, is traceable to the power station, which is thus seen to absorb about 15 per cent. of the receipts. Coal and coke have cost 0·52 d. per train mile; that is to say, about 14 per cent. of the power station expenditure and about 3 per cent. of the total expenditure. According to Mr. S. B. Cottrell's paper, read before the British Association last September, about 4·29 Board of Trade units are required to be generated for each train mile. Accordingly, says the Electrician, the cost of fuel on this line only amounts to about 0·12 d. per unit—an amazingly low figure.

Consul Matthews, says the Electrical Age, writes to the Department of State from Para that the Brazilian government is having a hard time in trying to operate the new cable to Manaos. The cable, costing about $1,000,000, was guaranteed by the company for thirty days. On the thirty-first day it failed, and no message has been sent over it since last February. It is hoped to have it in working order by the end of the year. Engineers now assert that a cable up the Amazon cannot be made a success, on account of the current and many obstructions in the river bed. The cable is of Siemens make and one of the best ever laid, but the conditions are said to be worse than those encountered even by cables in the busy Hudson River.

Dormann, a German experimenter, states in the Elecktrische Anzeiger, as abstracted in the Electrical World, that he has exposed dry plates in an inclosed holder to the sun's rays and obtained no effect, but when exposed to the rays of the moon during a night they were completely blackened. Pieces of metal produced no shadows, showing that they did not absorb these rays, which therefore traverse materials opaque to X rays; masonry was the only material found which was opaque to them. When the moon was near the horizon, shadows similar to those produced by X rays were obtained. Black materials near the plate, especially when they touch it, produced stronger light effects, and in some cases the structure of the wooden case was shown on the plate; the rays seemed to pass more readily through the densest bodies. The author suggests that the rate of oscillations of these rays is still greater than that of the X rays. His results have apparently been confirmed by no other investigator, and have not attracted much attention.

These statistics are given in the English Electrical Review: In Paris there are at present seven electric lighting undertakings, of which one is under municipal control. In London there are 13, of which three are the property of the parish authorities. In Paris the average selling price of the kilowatt hour is about 11½d.; in London it is about half that price. In October last year the number of lamps connected up in Paris was 545,914 (including 7,448 arc lamps); in London, at the end of the previous year, 1,178,000. In Paris, besides electric lamps, there are 220 electrically driven elevators, and the total energy supplied to motors is nearly 2,000 horse power. The consumption of electric energy in 1895 was: In Paris, 8,107,253 kilowatt hours; in London, exclusive of the City, about 9,553,105 units. In Berlin there are, on the network of the Berliner Elektricitätswerke alone, 166,192 incandescent lamps, 8,216 arc lamps, 1,347 motors developing 4,813 horse power, and 292 other appliances. The consumption of energy amounted to 9,770,800 kilowatt hours, and the dividend of the company to 13 per cent.

The Blot storage battery, invented by Mr. G. R. Blot and lately tested in London, possesses the following distinctive features: Two lead ribbons, each $\frac{1}{16}$ in. thick and not pasted with oxides, one being corrugated longitudinally and the other being corrugated crosswise, or it is embossed. These two ribbons are laid together and wound into a tank, like tape, and in the center of this tank is a lead core burned to all the layers of ribbon and putting them into electrical contact with each other and the core. Four or six of these tanks are fixed in an open lead frame by burning the ends of the core into the frame, and such a frame makes one plate of a cell. This Blot plate is perfectly elastic, as the ribbons only touch each other at points and are free to expand and contract in any direction. Their exposed surface is very large, being 0·33 sq. m. per kilogramme of weight. The storage capacity is thus great and the rate of charge and discharge can be rapid, as no buckling need be feared. Engineering says that 12·7 ampere hours have been obtained per kilogramme of plate, and the ampere hour efficiency was 88 per cent. and the watt hour efficiency 76 per cent. at the normal rate of discharge. At 2 volts pressure this would give 25,400 watt hour storage per metric ton of plate or 34 electrical horse power hours.

MISCELLANEOUS NOTES.

113,051 tons of British tinplate were exported to the United States last year. This is the smallest amount for any year since the amount exported became of material importance, and was 49 per cent. less than in 1895. In the year 1892, 276,497 tons were shipped to America.

Comparing the British Patent Office statistics for the eleven years following the coming into force of the 1852 law and a similar period dealt with by the 1883 law, very large increases in the number of applications for letters patent for inventions are shown in the later period. Mr. R. Core Gardner, F.S.P.A., summarizes the figures as follows:

	1852 Law.	1883 Law.	Increase
Applications	57,507	227,407	169,909
Patents granted....	38,918	110,683	71,765
Licenses assignm'ts	10,920	16,530	5,610

The capital of the United States has been located at different times at the following places: At Philadelphia from September 5, 1774, to December, 1776; at Baltimore from December 20, 1776, to March, 1777; at Philadelphia from March 4, 1777, to September, 1777; at Lancaster, Pa., from September 27, 1777, to September 30, 1777; at York, Pa., from September 30, 1777, to July, 1778; at Philadelphia from July 2, 1778, to June 30, 1783; at Princeton, N. J., June 30, 1783, to November 20, 1783; Annapolis, Md., November 26, 1783, to November 30, 1784; Trenton from November, 1784, to January, 1785; New York from January 11, 1785, to 1790; then the seat of government was removed to Philadelphia, where it remained until 1800, since which time it has been in Washington.

In the statistics recently published concerning the manufacture of paper it appears that New York and Massachusetts still hold their ascendency among all the States, in respect of the amount produced. One of the most interesting facts relating to the products of the Massachusetts paper mills refers to the material on which the United States has its bank notes printed. This is made by a private firm, the pulp being a mixture of linen, cotton, and silk, the silk threads coming into prominence after passing through the printing machine. Bank of England notes are all printed on plain white paper of great strength, bearing a distinctive water mark, while French notes are of paper that has hair in its pulp, the hairs coming out so strongly when photographed as to render any attempt at forging impossible. The Massachusetts paper for the government is declared to be the best in the world.

The use of compressed air in operating the pneumatic broom recently introduced at the railway yards of the Santa Fé line in Chicago, for sweeping cars, has proved a great success in its application to carpets and upholstery. Several hundred yards from the cars, says the Times-Herald, is the power house, in which is the powerful engine for compressing air which is to do broom service; through long underground pipes of about two inches diameter the compressed air is carried to the tracks; here a rubber hose is attached to the connection, at the end of this hose being a long handled nozzle, the latter consisting of an iron pipe a little larger than and about the same length as a broom handle. One end of this pipe is inserted into the rubber hose, and upon the other end is a brass fixture nearly a foot wide, a narrow slit running from one side of this to the other, say about $\frac{1}{32}$ of an inch in width. Through this aperture the compressed air issues at the rate of seventy-five cubic feet a minute.

Porous bricks were first prepared in connection with the lignite industry of the Halle-Bitterfeld district. Artificially, they can be made by admixing sawdust, tar refuse, peat, etc., to the clay, says the Trades Journals Review. The slates of the coal mines of Libuschin, near Kladno, have often been experimented with by Director Fitz, who hoped to gain a suitable brick material by mixing them with clay. The difficulty was to disintegrate the hard slate together with the soft loam or clay. Schmelzer, of Magdeburg, having solved this problem, excellent bricks are now made at Libuschin. The slates are wetted in their trucks; the clay, one-quarter of the mass of the slate, is likewise wetted. Both pass into the disintegrators, are sifted, and then conveyed by a stream of water to the brick presses. The baking requires no fuel, as the slates contain more than a sufficient percentage of combustible matter. But one has to take care lest the bricks should all cake together. They stand rapid cooling, and the radiated heat of the hot bricks can hence well be utilized. The bricks show blue lines or specks due to blackband, a coal-iron stone. They are made full and hollow. Tests conducted in Prague prove these bricks to be very strong and light, hard enough for paving stones, well suited for hearth stones, for building chimneys (on account of their porosity), and for supporting iron structures.

It is not generally known that in chemical analysis different results, in many cases, are obtained by different chemists from the same substance. Thus, according to a paper read by F. P. Dewey, of Washington, D. C., before the American Institute of Mining Engineers, this fact was illustrated, notably, in a case of examination of gold and silver in copper materials—a case in which there were twenty-six results by twenty chemists, working by two main methods, each by a single chemist, varying from 135·38 to 122·88, and averaging 127·94 ounces per ton, the extreme variation being 12·5 ounces per ton, or 9·77 per cent. of the average determination. In the silver assay of the copper borings, nine chemists' reports by the scorification method averaged results varying from 164·35 to 154·40, the rate per ton running some 159·36 ounces, thus showing an extreme variation of 9·95 ounces per ton, or 6·24 per cent. of the average. Further, fifteen chemists' reports of sixteen results by combined wet and scorification methods varied from 161·40 to 148·50, averaging 156·48 ounces per ton, the extreme variation being 13·9 ounces per ton, or 8·88 per cent. of the average. Summing up, there are thus shown twenty-six determinations by twenty chemists, working by three methods, ranging from 164·35 to 148·5, and averaging 157·67 ounces per ton, the extreme variation being 15·85 ounces per ton, or 10·05 per cent. of the average determination.

SELECTED FORMULÆ.

Metol as Photographic Developer.—Metol (methyl-para-amido-meta cresol) has met with considerable success as a developer for dry plates. The solution may be prepared as follows:

A.	Metol	15 gm.
	Sodium sulphite	150 "
	Water	1,000 c. c.
B.	Sodium hyposulphite	1 gm.
	Crystallized sodium carbonate	330 "
	Water	1,000 c. c.

When wanted for use mix 20 c. c. of A and 10 c. c. of B, diluting the mixture with 30 c. c. of water.—Pharmaceutical Era.

Printing and Writing Ink Removed from Old Papers.—The various processes used until now for the purpose of removing printing or writing ink from old papers consist in softening the printing ink by means of some essential oil (such as rosemary), turpentine, or kerosene oil, or in destroying the writing ink by means of an oxidizing agent, such as chlorine or chloride of calcium. In the first case the half slug thus secured always retains a very strong smell; in the second case the fibers are too sharply disintegrated. The new process, by Paul Lohmann, of Berlin, purposes the manufacturing with old papers of an odorless half stuff without making use of any oxidizing agents or essential oils. It consists in impregnating the paper in its warm status with liquid oleic acid; the impregnation takes place under millstones, with a pressure minimizing the quantity of oleic acid to be used. The impregnated paper is heated for one or two hours, according to the quantity operated upon, to a temperature of from 95° to 100° C. Printing ink submitted to treatment by oleic acid is sufficiently softened to allow it to be removed by running the finger over the paper. The paper, after being imbued with oleic acid, is washed in a spheric washer, with a solution of soda, under a pressure of between 1½ and 2 atmospheres. The quantity of caustic soda to be used is proportioned to the quantity of oleic acid, and just enough of it should be used to secure thorough saponification of the said acid. A washing of three hours' duration, under the above pressure, brings the operation to an end. The printing ink is found partly dissolved, partly suspended, in the solution of soap. The stuff is then submitted to a moderate pressure, after which it is heated in a worm containing washtub. The remainder of the ink can easily be collected by skimming or drawing. A half stuff of perfectly pure white is thus secured, which can easily be converted again into paper without any further operation.—Revue de la Papeterie.

Quick Setting Glue Cement.—For paper, cloth, leather, wood, earthenware, etc.:

(a)	White fish glue	1 lb.
	Soak four hours in	
	Cold water	30 fl. oz.
(b)	Dry white lead	4 oz.
	Mixed with	
	Hot water	2 fl. oz.
(c)	Ninety per cent. alcohol	4 "

Dissolve a by aid of a glue pot, then slowly add b. Cook for about 10 minutes, then let cool to about 100° F. Now, with constant stirring, add c. This cement sets in about 1 minute, due to the alcohol used. It is non-elastic and extremely hard. For leather and cloth, if wanted pliable, add 2 or 4 oz. of glycerine, according to the elasticity desired. The above cement, without glycerine and with the addition of 4 oz. red lead, will stand a bath in hot oil without frying out.

Shellac Cement (Water).—For fastening leather, wood, stone, etc., to metal or other substances:

(a)	Orange shellac	4 oz.
(b)	Concentrated ammonia	8 fl. oz.
	Distilled water	6 "

Weigh out a, place in a quart fruit jar, and add b. Seal up the cover so as to prevent evaporation, and set aside. In about six days the shellac will be perfectly dissolved, especially if the mixture be shaken occasionally. In order to use this cement, it should be poured into a shallow dish and evaporated until quite thick and gummy. If you get it too thick, it is easily thinned with a little hot water. The only objection to this cement is the color, which assumes a deep maroon tone when mixed with ammonia. It is very tenacious and is useful for many purposes.

Spirit Cement (White).—For metal, glass plates, wood, etc.:

(a)	Bleached shellac	1 lb.
(b)	Ninety-five per cent. alcohol	1 qt.

Dissolve a, which should be fresh and finely pulverized, in b. Solution may be made cold, the operation being hastened by agitation. When dissolved expose in an open porcelain or earthenware dish, in a dry atmosphere, until evaporated to a thick, gummy paste; or, if time be an important feature, heat some sand in an iron dish, extinguish the fire, then place the shellac mixture on the hot sand to evaporate. Do not have the sand too hot, as it might crack the dish. For a rapid setting cement, evaporate down until quite thick, i. e., liquid but not dry; then add a very little of the following mixture:

Wood alcohol	4 fl. oz.
Solvent naphtha (benzole)	2 "

Caution: Keep away from the fire.

Oil for Floors.—

(1)	Neatsfoot oil	1 part.
	Cottonseed oil	1 "
	Petroleum oil	1 "
(2)	Beeswax	8 "
	Water	56 "
	Potassium carbonate	4 "

Dissolve the potash in 12 parts of water; heat together the wax and the remaining water till the wax is liquefied; then mix the two and boil together until a perfect emulsion is effected. Color, if desired, with solution of annatto.

(3) A writer in a contemporary last year proposed a formula for an emulsion containing paraffin oil, 8 parts; kerosene, 1 part; lime water, 1 part.—Pharmaceutical Era.

HOW TO RETOUCH, IMPROVE AND TREAT NEGATIVES, POSITIVES AND PHOTOGRAPHS.

By ROBERT GRIMSHAW.

THE following hints have been mostly translated from a work in German and may be said to describe German methods:

While it sometimes happens that one gets, through development alone, negatives good enough to make faultless positives without any retouching of the plate, it is not always the case. Aside from mechanical faults in the plate, such as scratches, pinholes, etc., that must be removed, there is an entire class of views that cannot be used without retouching. In this list may be reckoned bust pictures, in which, by reason of their size, all faults are conspicuous, while in cartes de visite of the whole figure and in groups, etc., where the entire form is not larger than in a carte de visite, the faults are so minute as to be not worth touching up. There are but few negatives which cannot, by proper retouching, be much improved; but this can seldom be done by amateurs, requiring as it does a skilled and practiced touch. It is much more easy to spoil a negative by unskillful retouching than to improve it by the highest grade of skill.

The following remarks are intended only to help those skilled amateurs who have taste and judgment.

It is well known that, except with the chromatic plates, every imperfection of the skin, as freckles, moles, etc., shows plainly on the plate. There are also under the eyes and in the corners of the mouth greenish and yellowish half tones which in the plate produce the effect of enlarging the appearance of the mouth and making the eyes seem deeper set than in reality. Also wrinkles appear deeper than they ought, and certain shades of hair are reproduced with false "values;" as, for instance, red hair appears black. Blue eyes also seldom appear other than white.

These facts call for skillful retouching to produce a natural resemblance—to say nothing of cases where a moderate amount of flattery is justifiable—or politic.

What materials and what methods shall the amateur employ to do skillful retouching?

The materials necessary are: one bottle of malt oil, one No. 2 and one No. 3 lead pencil, one leather or paper wiper and one of linen, one marten hair brush No. 1 and one No. 3, one cake of lampblack water color, and one tube each of reddish and of blackish retouching paint. In the United States a preparation called Gihon's opaque is more extensively used than lampblack water color.

Mechanical injuries to the film, as scratches, blisters, pinholes, etc., are removed by the brush and lampblack.

To dilute the colors so as to be most available, there is used a solution of white of egg, made as follows: The white of an egg is put into a bottle containing about 100 cubic centimeters (equal say 3⅓ fluid ounces), and there is added thereto 1 to 2 cubic centimeters of strong ammonia; the bottle is then filled with pure water and the whole well shaken together. This mixture will keep for a month.

The hair pencil is moistened with this solution, color then taken on it and a good point put on the brush by turning it on the cake of color. For pinholes the brush is held vertically. In removing scratches the hair pencil is held with the top inclined from the operator.

More important faults in the film are repaired or counteracted by fine dots of color quite closely placed. The finer these dots, the better. Care must be taken to have the color properly and evenly moist. When the color is too thin, there comes a ring around each dot; if it is too thick or dry, the brush will not give it down properly.

In retouching a negative the artist or operator must have in sight a positive therefrom, so that he can see what needs improvement or alteration.

In portrait work the lead pencil is used. As graphite does not readily mark the gelatine of the film, mattolein is used. A little of it is put, by means of the cork stopper of its bottle, on the spot to be retouched, and rubbed with linen or paper so that there remains only a fine film, which in a few minutes is dry enough for the work to begin. A fine pumice stone powder may be used in place of this preparation, rubbed over the film with the ball of the finger, which will give the requisite tooth. Commencing with the darkest part of the negative, as the cheeks and forehead, No. 2 pencil is used, and the imperfections of the skin touched up, so that the tone of the whole surface appears unspotted. Wrinkles and crow's feet must be only toned down, not entirely removed, else the likeness would largely disappear. In this work, also, the "dot" style is recommended, as it best simulates the grain of the skin. The dots may be softened in outline with the wiper.

Care must be taken not to retouch too much. One must remember that the skin of an old person cannot and should not have the smooth poli h of a child's.

For the half tones and high lights of the negative the hard pencil should be used. Next the too transparent places under the eyes should be lightly touched up with criss-cross strokes, and blended with the wiper, and the mouth then made smaller (i. e., not made to appear too small) by touches at the inner corners. In most cases the wrinkle running down from the nose to the corners of the eyes should be toned down, in order to avoid a morose expression, and the shadows under the nose and chin are usually to be lightened.

Where the hollows under the eyes and the shadows under the chin are too pronounced, this may be remedied by a layer of color on the glass or plain face of the negative. Lampblack is laid on with the hair pencil; then with the moist (not wet) finger tip the layer of color is patted, so as to give it a grain, as well as to even it. In the same manner areas which are too transparent to properly represent blond hair on the positive are touched up.

Taste, judgment and experience will tell just where to touch and how far to go with the operation.

For landscapes and architectural subjects, and for snap shots, as of street scenes, areas, which print too dark or too light, may be skillfully retouched, so as to greatly improve, without falsifying, the positive. For this work, on small areas, there may be used on the film side of the plate, lead pencil, wiper, and powdered graphite, or on the glass side, have pencil and water color. Larger "masses" are best handled as follows: A two per cent. solution of Rohcollod (crude collodion) is colored by metanilin yellow or "aurantia," the glass side of the plate poured with this, and, after drying, the layer is removed (over those places where no coating is desired) with a knife blade. Special places may be more heavily touched (on the glass side) with the hair pencil dipp d in the colored collodion.

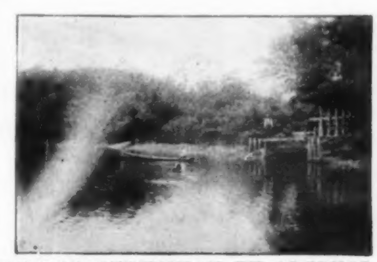
Weakening portions of the negative may be accomplished in various ways. This is of use where there are sharply bordered areas, the outlines of which are too pronounced.

Then the following solutions are used: One per cent. and five per cent. solutions of red prussiate of potash, and a ten per cent. solution of hyposulphite of soda. A soft hair pencil and a little filter paper are necessary with these.

The negative which is to be weakened in part is softened in water for about ten minutes, drained, and then held horizontally with the left hand (with the film side upward) over a white background, so distant that the degree of transparency may be well controlled. It is well to rig up a holder so as to give the use of both hands.

Where only a slight weakening is necessary, the spot is gone over with a hair pencil, dipped in the one per cent. solution of red prussiate of potash; in the case of sharply bordered portions, going carefully around the outlines; and in others not bothering about the outlines and only seeing that those portions which are to be most weakened are most covered with the red prussiate solution. After a few minutes the excess of solution is removed by filter paper, and the spot is touched with the hair pencil dipped in the hyposulphite. This latter operation at once brightens the spot. For more marked lightening, the five per cent. prussiate solution is used.

If it has been necessary to take the negative facing the bright sunlight, the trees, etc., in the foreground will be surrounded with strong, bright patches. A convenient and sure method of remedying this evil is with alcohol. A linen rag is moistened in absolute alcohol, and lightly rubbed over the areas in question. The film is thus partly washed away—as may be seen by the blackening of the rag. This operation is continued until the desired amount of change is effected. The two accompanying pictures illustrate the improvement.*



BEFORE REDUCTION BY ALCOHOL.

AFTER REDUCTION.

In landscapes a too dark or too light sky produces an unpleasant impression; and this may be lessened by the addition of clouds. If this is done properly (of course one must not commit such absurdities as to print on a negative in which the light comes from the left clouds illuminated from the right), the effect is well worth the trouble.

If the negative has too light a sky, it is all ready to work on; if, however, the sky is too dark, the horizon must be gone over (on the film side) with the hair pencil dipped in color, over a width of one-fourth to one-half inch. The sky is carefully removed from a positive print of the same negative and so gummed to the glass side of the negative that the entire sky is covered and print is white.

To print in the clouds the positive is then thus handled:

First the "cloud negative" is put in the printing frame, the positive next and then the cover put on. The frame is then brought into the light and the land part (that is, all but the sky) protected by a screen cut from a positive, or by a cloth laid along the boundary line between sky and land. As dark negatives print quickly, this part of the operation takes but little time. Gelatine film clouds are the best to use, readily purchased from dealers in photo materials, as they may be used for either right handed or left handed shadows.

And now a few words as to retouching of positives. This is only necessary in the case of white spots appearing on all copies by reason of excessively retouched spots on the negative or only on copies caused by dust on the negative. In these instances the hair pencil and the white of egg solution are used in connection with the tubes of "positive retouching" color. The latter is thinned with the white of egg solution, taken up with the hair pencil and dotted on the white spots.

When portraits are taken in the open air the high lights on the eyes are usually too large and must be somewhat diminished; also, the pupils must be enlarged.

In conclusion, as it is much easier to spoil than to improve a negative by retouching, it is well to commence with old or valueless ones, and to accomplish good work before trying one's 'prentice hand on new or important plates.

* We are indebted to the Photo American for the use of these cuts.

PORTABLE AUTOMATIC OXYGEN GENERATOR.

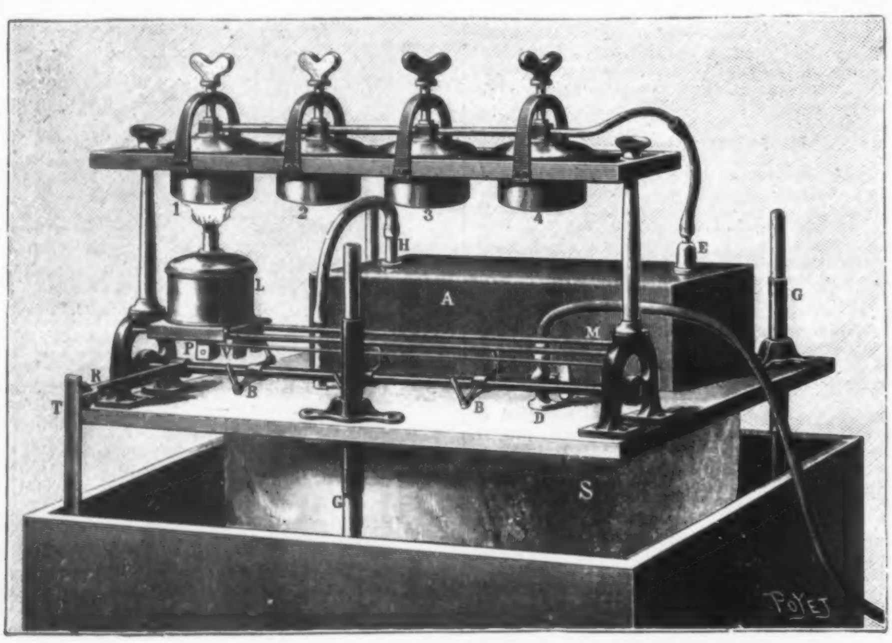
We have several times already discussed the question of light for lantern projections, and have made known the new apparatus designed to furnish it as fast as they have appeared. As a general thing, it has been supposed that the operator had electricity, illuminating gas, or a cylinder of compressed oxygen at his disposal. The use of electricity is quite limited, and gas is now found in many localities, but it can be dispensed with in employing the Molteni ether saturator. What may be wanting is oxygen, for, notwithstanding the fact that it is now easy to find it in very portable cylinders, there are persons who, although no accident has ever happened, do not care to handle a gas compressed to 120 atmospheres. Moreover, if a person is living in a remote locality, or if he is traveling, it is better that he should be able to manufacture his own oxygen. A good while ago there was arranged to this effect a special apparatus composed of a retort, a purifier and a rubber bag. Indeed, up to the advent of the electric light and compressed oxygen, these were the indispensable accessories of every projection lantern. In fact, they are still the only ones that we have to employ in such a case, and so the Clement & Gilmer apparatus, that we are about to make known to our readers, presents, as a novelty, only its very portable and, consequently, very practical arrangement.

Among the different methods of preparing oxygen indicated by chemistry, we have always recommended as being the most practical, the decomposition of chlorate of potash by heat. In order to facilitate the disengagement of the gas, a mixture of three parts of chlorate to one of binoxide of manganese is made. This is the process that is employed here, and the above mixture is furnished in the form of compressed cakes made especially to suit the dimensions of the retorts. The latter are four in number, closed by covers with a bridge and bolt, and connected by the same disengagement tube. Beneath them there slides upon two rails an alcohol lamp, L, which places itself automatically beneath each retort according to requirements. The entire affair is mounted upon a platform supported by the upper part of a bag, S, designed to receive the oxygen. Guides, G, four in number, assure the regular ascent of the platform in measure as the bag inflates. An iron plate box, A, is filled three-quarters full of water for washing the oxygen, and, at the same time, forms the weight necessary for compressing the bag in order to assure the passage of the gas into the blowpipe when the cock, D, is opened.

The operation of the apparatus is very simple. After the four retorts have been charged with the prepared cakes (or with a mixture of chlorate and binoxide made by the operator himself), they are closed hermetically by means of the bolts, and the lamp is lighted under retort No. 1. At the end of about a quarter of an hour, the oxygen is heard bubbling in the purifier, it having entered through the tube, E, to make its exit through H. The entire system is then seen to rise through the inflation of the bag with gas.

It is now possible to light the lantern. We have said that when the supply of chlorate in the first retort is exhausted, the lamp places itself automatically under the second. To this effect, it is placed upon a small carriage that is provided with a spring box, P, and slides upon the rails, M. A flat steel spring, which is coiled in the box, P, is attached to the support placed toward M, so that the carriage has a tendency to move from retort No. 1 to No. 2. But it is held under No. 1 by a tappet, V, that abuts against a stop, B. The latter constitutes a sort of anchor escapement, and the rod that carries it is fixed to an arm, R, which is at right angles with it. At its extremity this arm carries a wheel that follows a guide, T. As soon as the bag has received nearly the entire quantity of gas that the retort is capable of producing, it lifts the platform to a sufficient height to allow the wheel, R, to ascend above the rod, T. It is then that the stop, B, tilts and allows of the passage of the tappet, V, which then abuts against the following stop under the second retort. In measure as the oxygen is consumed, the bag descends, and the wheel resumes its position against the rod. It is not until about a quarter of an hour that the gas begins to form in retort No. 2 and lifts the bag anew, and so on up to the last retort.

It is possible for the blowpipe to operate thus for an hour and a half; but if it is desired to prolong the projection, there will be plenty of time to recharge the retorts before the supply in the bag is exhausted. The rods that serve as a support or guide are removable, and the entire affair may be placed in a box 20 inches in length by 18 in width and 10 in height.—La Nature.



PORTABLE OXYGEN GENERATOR.

MAKING CLEAN CASTINGS.

To make castings so that when finished they will be perfectly clean is an undertaking that should be more universally successful than it is. The reason why there are so many failures can generally be traced to the moulder's ignorance of the safeguards necessary. But few of those who spend their lives in the foundry take the trouble to go into a shop and look at their castings after they have been finished or while they are undergoing that operation. The foreman of the foundry goes to the moulder and tells him that the cylinder he cast a day or two ago is full of dirt and will have to go to the scrap heap. The moulder replies that the iron is dirty, makes a second one the same as before, with the same result, and gives the same excuse. Now he has never studied the subject of cleaning castings as thoroughly as he should have done, and many so-called foremen are unable to help him out of his difficulty.

The most prolific cause for trouble is the too frequent use of dirty iron. The moulder goes to the cupola and gets a ladle of hot metal, looks at it and says: "This is too hot." He finds some warm gates or scrap, puts it in the ladle, stirs it up until it is a good red, and then pours it. The next morning he removes the casting and observes the dull blue skin to which the sand has not adhered very closely. He thinks that it is a very nice casting, but when the lathe begins to work on it he finds it full of dirt, and it has to be thrown out or plugged up, and is not a first-class job.

Dull iron will never make clean castings. The moulder may put all the cleaner or whirl gates that have ever been invented in a mould, but if poured with dull iron, will be dirty nine times out of ten. With my experience, the hotter the iron, the cleaner the casting. Perhaps, next to the foregoing, the most frequent reason for poor castings from that defect is owing to improper gating; but few moulders pay proper attention to this or take the necessary precaution to insure the best results.

A foreman gives a moulder a job. He looks it over, measures it, goes through the yard, finds a flask for it, brings it in, rams up his pattern without stopping to think about gating or pouring until he puts on the cope; then he finds that the flask is too small to permit of its being gated where it should be, and finds that he has to pour it on the top, possibly near the center. After hunting around and securing a couple of gate pins (perhaps both too large), he rams up the cope, finishes it, puts a basin to the gates, and when he comes to pour it, finds that the gates let the iron into the mould too fast, and he cannot keep the basin full; so dirt and all go into the mould; while, if judgment had been used and appropriate gate pins secured, both could have been kept full and the casting would have been good if poured with hot iron, notwithstanding the size of the cope.

In making cylinders for paper mill machinery—which run sometimes from 24 to 96 in. in diameter and from 48 to 98 in. long, and are not very thick—a moulder has a chance of testing his ability in this direction, for he must have the casting clean from dirt and blow holes, as an imperfection of the smallest kind may cause them to be thrown out. In my experience the best results have always been secured by pouring them direct from the top end or edge, as they are cast always on end. Small round gate pins about ½ in. in diameter should be placed 8 in. apart or less, and when the moulds are closed the runner box should be placed on top with a large basin that will connect them all. If this method is followed and the mould is in good shape and the hottest iron is used, a good casting can be secured every time if the basin is kept full.

I have poured one that was 48 in. in diameter and 60 in. long in 11 seconds. The iron dropped from the top of the mould to the bottom, over 6 or 8 in. all around, keeping it alive and hot. It carries all the dirt the mould makes or is in the iron up to the 4 in. head on top.—The Foundry.

BRIQUETTES FROM CULM HEAPS.

Briquette making has become quite an industry in Germany, Austria and France, where the fuel question is much more important than it is in this country, and the culm piles are being carefully utilized in those countries and made a profitable source of income.

Brown coal has so far been the chief material for briquettes, but in latter days experiments with briquettes of solidified petroleum or residuum have been made, which, however, did not result satisfactorily, for the reason that the boilers were unable to withstand the intense heat developed by this kind of fuel.

L'Industrie describes a process devised by the chemist Velna, who uses petroleum or mineral tar only for enriching culm and other inferior, formerly worthless combustibles, and produces briquettes from this material, the heating power of which is 30 per cent. higher than that of good coal.

He first prepares a mixture consisting of petroleum or bituminous shale tar, oleine and soda in suitable proportion, and by this means the culm, slack, or coal dust is cemented together. Three kinds of briquettes are produced in this way, namely, industrial briquettes for general firing purposes, gas briquettes for the manufacture of illuminating gas and metallurgical coke.

If culm or dust from a good coal valued at $1.20 would be taken for the production of briquettes, 6 per cent. of the mixture would be sufficient. The price of a ton of briquettes would then be as follows:

1,800 pounds of coal dust at $1.20 a ton	$1 25
120 pounds of the mixture at $12 a ton	72
Cost of labor	40
Total per ton	$2 25

If waste of a poorer coal be used, 10 per cent. of the mixture would be the proper proportion. Supposing the waste, culm or slack cost $1 a ton, the price of a ton of briquettes would be $2.50 under these circumstances. In the first case, there will be a saving of 25 per cent., in the second of 16 per cent. Considering further that the heating power of briquettes exceeds that of the average coal by at least 25 per cent., 1,500 pounds of briquettes would be equal in heating value to a ton of coal. This would mean also a great saving in storeroom on board of steamers.

PREPARATION OF PAPERS FOR PRESERVING GOODS OR ARTICLES WRAPPED IN THEM.

An anonymous correspondent of the Pharmaceutische Centralhalle says:

Preserving papers, or papers the object of which is to preserve in a normal condition articles or materials wrapped in them, are prepared, as a general thing, by immersing and imbibing paper of a suitable nature in solutions of a preserving material (varying, of course, according to circumstances), draining off, passing between rollers, and drying at a suitable temperature. After drying, the paper is usually pressed or planished and put up in packages.

With the foregoing as general directions, we reproduce the following formulæ from the Neuste Erfindungen und Erfahrungen:

BUTTER PRESERVING PAPER.

Cooking salt, in fine powder	160 grains.
Saltpeter, in fine powder	320 "
Whites of	20 eggs.

Beat the albumen to a froth, mix the salts, and add the mixture to the froth, little by little, with constant stirring, until a solution is formed. In this imbibe a good quality of bibulous paper and hang it across strings to dry. When dry go over each sheet with a hot smoothing iron, the face of which is kept well waxed.

PAPER FOR SILVERWARE.

Caustic soda	6 parts.
Zinc oxide	4 "
Water sufficient.	

Dissolve the caustic soda in water until a density of 20° Baumé is obtained (s. g. 1·161, to obtain which, near enough for all practical purposes, take 11 parts sodium hydrate to every hundred parts of water), add the zinc oxide and boil for two hours, if possible under a pressure of five atmospheres. After cooling, thin down with water to 10° Baumé (s. g. 1·075). Proceed as in the general directions. [Paper for wrapping silver should be soft and thin, so that it will cling to the surface of the article wrapped in it, without danger of scratching it. A good article of tissue paper is excellent, but the best is a Japanese fiber paper of great softness and thinness, yet very strong.—Editor National Druggist.]

SALICYLATED PAPER.

Divide any desired quantity of salicylic acid into two equal parts. Make a solution containing 3 parts of Glauber salt and 7 parts of borax in 58 parts of water, heat and add one of the parts of salicylic acid. Digest the remaining half of the acid in a volume of hot glycerine about equal to that of the saline solution. Mix the two liquids and then carefully add water until a solution of about 3 per cent. of salicylic acid is obtained. This answers for thin paper, but a thicker paper requires a 5 per cent. solution. The best paper for the purpose is one having a satin finish. If the salts show a tendency to crystallize out on the paper on drying, more glycerine is needed. Each sheet should be put in separately and kept immersed for four or five minutes, the solution being maintained at a temperature of not less than 150° F. The paper should be dried at ordinary temperatures and kept pressed between pasteboard, or in rolls.

WATERPROOF PAPER.

In a saturated aqueous solution of borax dissolve a sufficient quantity of shellac, by the aid of a gentle heat. If a colored paper is desired, any suitable anilin color may be added to the solution. Dip the paper in sheets separately and proceed as directed in general directions.

Another recipe for waterproofing is as follows: Dis-

solve 24 parts of alum and 4 parts of shaved white soap in 32 parts of water. Dissolve in a similar quantity of water 6 parts gum arabic and 6 parts of glue. Mix the solutions; heat, with stirring, until homogeneous, and then imbibe the paper in the hot liquid. Dry over threads at ordinary temperature, or in moderately warmed rooms.

PAPER FOR RETAINING MOISTURE.

Make a solution of potassium acetate or sodium acetate, and add to it either grape sugar, dextrine, or powdered starch. A little carbolic acid or salicylic acid should also be added, to prevent chemical changes. Treat the paper with this solution after general directions.—National Druggist.

WOMEN BICYCLE RACING IN LONDON.

ONE of the prominent features of the cycle show held in the London Aquarium, under the auspices of the Stanley Club, was the women's bicycle race. Our cut, for which we are indebted to Illustrirte Zeitung, shows the winners approaching the tape, Mlle. Eglee (No. 9) and Miss Harwood (No. 8) being the first to reach it.

THE CONFESSIONS OF A COCAINIST.

IT cannot be without medical interest to hear from the lips of a devotee, and that devotee a medical man of great mental endowments and uncommon training, some account of the manner in which he found himself affected by the continued abuse of one of the subtlest of seductive drugs, cocaine, even though his whether, after all, he has told the truth about the date of his first injection. However this may be, he took cocaine and morphine from that time forward, increasing the dosage to six or eight grains daily of each drug, and soon (he says within a month) came to take not less than eighty to one hundred and twenty grains of cocaine daily. His highest single dose was twenty grains, the result being that he fell down suddenly, and remained in a cataleptic condition for some hours. His description of his symptoms is graphic, and, I think, in the main reliable:

"The first feeling a cocainist has is an indescribable excitement to do something great, to leave a mark. But, alas! this disappears as rapidly as it came, and soon every part of the body seems to cry out for a new syringe. The second sensation—at first, at least, no hallucination—is that his hearing is enormously increased, so that he really (?) hears the flies walking over the paper. Very soon every sound begins to be a remark about himself, mostly of a nasty kind, and he begins to carry on a solitary life, his only companion his beloved syringe. Every passerby seems to talk about him. Often and often have I stopped persons, or ordered the police to arrest them, thinking they were talking about me. After a relatively short time begins the 'hunting of the cocaine bug.' You imagine that in your skin worms or similar things are moving along. If you touch them with wool (especially absorbent wool) they run away and disappear, only to peep cautiously out of some corner to see if there is any danger. These worms are projected only on to the cocainist's own person or clothing. He sees them on his washing, in his skin, creeping along his penholder, that time I bought three St. Bernard dogs, thinking they would protect me; but one night I found out they were talking about me—how they could get rid of me—so I stood up and shot one of them with a revolver, which I always used to carry. I think this was the most dreadful night of my life—I standing on the table, with an Indian dagger and a syringe on the ground; one three foot high dog going to die, and two rather dangerous dogs roaring and groaning aloud, reproachfully looking at me, who always fancied, 'Now comes the moment when they will tear you in pieces.' I stood the night on the table, till the arrival of my wardsman, who hardly risked to enter the room.

The strangest thing, however, in the cocaine habit is that there seem to be two souls in the cocainist—one infested by the cocaine, suffering, and tortured by its effects; the other normal, laughing at his fears, and saying: 'What nonsense! it is only an hallucination produced by an injection.'

Not frightened enough by these experiences, and escaping from the troubles produced by his conduct, on he goes, taking more and more; and then enters a new kind of illusion, which finishes him up for the mad house. I mean the revolting, dirty, sensuous illusions. The remembrance of it is for me so awful that I only tell you that one day every person I saw, near or far, appeared to be naked and in the most lascivious positions, alone or with others. I remember on entering the surgical theater to have seen everybody—operator, assistant, students—naked. In terror, I took to flight, ran to a medical friend at a lunatic asylum, and was placed under restraint. Well, this ended (January,

WOMEN BICYCLE RACING IN LONDON.

record be not so detailed as that of De Quincey or so thrilling as that of Bayard Taylor.

My patient relates how he first came to take cocaine. It was in the year of 1885, when serving in the German army. "I took it inwardly," he said, "in one grain doses, and remember very well the marvelous effect when after marching 'par force' thirty miles in ten hours, including one hour and a half rest, I found myself on arriving at quarters fresh, untired, not thirsty nor hungry, but with bleeding feet." Going back to his medical studies, he had nothing more to do with the drug for some four years, though frequently brought face to face with morphinists and morphine maniacs. In 1889, however, he was sent to relieve a country physician, whom he found lying in bed unconscious with a syringe sticking into his breast. Never in his life, he says, has he seen a more startling effect than that which then followed the injection of a twenty per cent. solution of cocaine. "Nearly instantaneously he sat up in bed, with perfectly clear eyes, and received me, a total stranger, in the most cordial manner." The occurrence haunted him day and night, but it was not until summoned to a late confinement some weeks later, when stiff and unable to move with lumbago, that he was weak enough to follow suit. "That night in the month of November, 1889, settled my future. Remembering well the effect of the cocaine, I took a syringeful (one-half centigramme) combined with morphine, and two minutes afterward one centigramme. Five minutes later I was ready to start a couple of miles in a snow storm." He repeated the performance before driving home again. This early repetition, taken in conjunction with the dosage, raises the suspicion as to but not on other people or things, and not on clothes brought clean from the laundry. How is this to be explained?"

In my opinion it is a question of disturbance in the frontal cortex, originating, perhaps, in skin dysæsthesiæ, and not a simple visual hallucination or retinal projection. Whatever its origin, it is characteristic of the cocaine habit, and readily distinguishable from the hallucination due to alcoholic excess. The sight presented by such a patient "hunting for the cocaine bug" is one which, once seen, can scarcely ever be forgotten. In a recent case—that of the wife of a medical man—the patient was about to consult a skin specialist for this psychical hallucination! He continues:

"About the same time appear many other hallucinations of the opticus, and, strange to say, self-suggested hallucinations also. Night turns to day. You sit up in your room syringing till the morning, and then fall asleep in a coma. In my case this occurred to such an extent that I had to engage a hospital warder, who came in the morning to revive me with about ten syringes of five per cent. solution, so that I was able to drive, not walk, fearing some one might garrote me."

Other dreadful hallucinations I had in thousands, all of a persecuting character, and frightening the life out of me so long as the effects of the drug lasted. You see small animals running about your body, and feel their bites. Every object seems to become alive to stare at you from all corners—look revolvers, knives, etc., and threaten you. Yet, as soon as the effect of the injection is over, you laugh at it, and produce willingly by a new injection the same terrors. About 1890) my pure cocaine habit, which in a year's time eased my pockets of about $8,000.

It was early in 1891 that I first met him in Melbourne. He was then a morphine maniac, as well as a cocainist. His appearance was characteristic. He was pallid and yellow, with hands trembling, cold and sweaty, eyes sunken and glistening, pupils dilated, breathing short and hurried—restless, irresolute and careless of his personal appearance. He appeared the embodiment of one who had just emerged from some terrifying experience. He soon became known to every chemist in the city, and from one and all bought syringes, cocaine and morphine whenever money or credit permitted. Frequently his needle would be fastened to his syringe by sealing wax, shellac, etc., and when he had no needle at all he would cut an opening with his knife and insert the end of the syringe direct. Almost the whole of his body except the face was marked with needle scars. A common practice was to mix four grains of morphine with two of cocaine—"sixpen-north"—in a two drachm bottle, and inject by syringefuls until all was exhausted. The change from the shivering wretch before injection to the self-confident neurasthenic after injection struck all beholders. His experiences embraced the whole gamut of wretchedness and shame, and included both hospital and jail.

As regards abstinence, he agrees with Erlenmeyer, that the symptoms are neither manifold nor severe. He said:

"The tales about neuralgia, etc., are all lies, and, after two days' abstinence, the craving is relatively small—you feel, in fact, nothing, but the thousand possibilities of suggestion form the real danger. Then

comes the maniac desire: it fascinates your whole body. Suddenly your chest seems to be screwed together, you cannot breathe, your eyes protrude, and, if you have no cocaine, you either commit suicide in some way without intending it, or murder one of your warders."

He summarizes the physiological effects of the drug as follows:

"The cocainist early loses all appetite for solid food, but likes sweets, lollies and cakes. Diarrhea is soon produced, and immediate evacuation often follows big injections. Upon the muscular system the drug, as is generally recognized, acts as a most powerful stimulant for either single or continued effort. [Not only could he make long marches without becoming tired, but on one occasion, after injection, he says he lifted a cab with one hand on the axle.] It increases also the number of the respiratory and of the cardiac contractions (with vascular dilatation), as well as the quantity of urine (with large or repeated small doses, incontinence follows), and, enormously, the amount of sweat. Hence the great loss of weight. It stimulates also sexual appetite, though, later on, power is lost while desire remains. After each injection the pupil dilates, but remains dilated only because injections are continued. [When taking very large doses, he remarked that his iris seemed to separate into broad radii, with free spaces between.] As regards the brain, mental processes seem quickened, but a kind of hypnosis intervenes, so that the brain works without, and even against, the will. Immediately after the injection the cocainist becomes excited, and remains restless while under the influence. He likes manual work, however trifling, but has neither will nor ability for mental work, because he is bound to inject every five or ten minutes, or, in fact, because he never ceases to inject. The hallucinations and illusions already mentioned make their appearance early. One syringe self-injected is, in my opinion, absolutely sure to produce the fascinating desire for a second. The individual is almost certainly then a cocainist, and will procure the drug for self-administration, even when apparently it is impossible to do so. All watching is useless. He has thousands of excuses to get a moment to himself, generally in the neighborhood of some chemist. Unscrupulous—even though still aware to some extent of his ties—he will get it, dishonestly if necessary; and, even when not craving for it at the moment, he will get it, because his only idea is to have it with him. The sense of right and wrong is not abolished, but he does not care much about trifles. Thus he sinks lower and lower, disregards his personal appearance, and, because they will always show, or sham to show, a certain respect to his higher education, he seeks the association of lower people. He thus becomes a scoundrel or criminal, and does not mind to do so so long as he gets his cocaine. It is extremely seldom that he makes a trial to free himself of the habit, mainly because he does not see any reason to do so. Suicide he never contemplates so long as he can get his beloved drug."

For purposes of contrast it may be well to add his experience of the effects of morphine:

"A man may be for years a confirmed morphinist without being a morphine maniac, and the results are very different in the two classes of cases. I have met hundreds of men, distinguished by intellectual power and refined sense, who were confirmed morphinists [and certainly, if his list is reliable, the names fully bear out his statement]. Such hate every low, unæsthetic object, and often indulge in princely habits which may cause their ruin. Morally they never descend to a low level, except, perhaps, during abstinence. By way of illustration I may quote the case of a morphinist who, during abstinence, stole an ounce of morphine, but who, as soon as he had injected himself, sent the money anonymously to the chemist from whom he had stolen it. Mentally there is undoubtedly a stimulating effect on the brain so long as the influence of the drug lasts. The brain seems to work quicker, conceive quicker, and, before all, the morphinist likes to do mental, though he detests manual, work. In some eight hours after injection the sublime quietness of mind is replaced by restlessness. The habitue generally becomes pale, and loses both flesh and muscle. Many, to obtain a little color, add a certain amount of atropine to the morphine. The desire for fluids seems diminished, and satisfied with choice drinks, if these can be had. To this, perhaps, may be ascribed the small quantity of urine generally passed. Morphinists can take regular meals, preferring well flavored and sour articles, such as curry, pickles, etc. The sexual powers are progressively diminished, and women despised, except the highly educated and brilliant. A sense for the eternal feminine remains, but no power, no desire.

"The morphine maniac is quite a different person. One syringe self-injected for any pain is sure to have, as a necessary consequence, a second as soon as the pains recur, even though distressing sequelae have intervened. Even more dangerous in the establishment of the habit is the use of the syringe for insomnia. Soon he injects for the sake of injecting, until he gradually falls into a state of imagined abstinence. His moral balance disappears early, and for him a word of honor does not exist. Feeling that he is sinking to a lower level, he may make enormous struggles, but in vain. He cannot—he despairs, and gives up every hope. Highly increased doses momentarily restore his moral sense, but when the eight hours are over he is worse. Even when not abstaining he may commit suicide, because he can no longer face his moral degradation. His despondency, his imagined abstinence, and the frequent injecting soon make regular brain work impossible, except, perhaps, in the morning. Even if able, however, he no longer cares for it, seeing the uselessness of his exertions. So long as he is under the influence he never has hallucinations, and seldom any illusions. Like the morphinist, he becomes pale and wasted, and shows the influence of the drug upon skin, bowels, respiration, eye, etc. He neglects his eating, however, and constipation frequently lasts for weeks, relieved immediately by a large dose of cocaine."

Regarding diagnosis and prognosis the same authority says:

"The diagnosis of a morphinist is sometimes exceedingly difficult, because he tries everything to hide his habit. The contraction of the pupils, the marks of the syringe (if hypodermatically administered), and the 'going away' from other people at certain hours, are, in my opinion, the only objective symptoms. The morphine maniac is easily found out by the foregoing symptoms, by his dislike for females, and by his sudden nervousness and paleness, which disappear immediately as soon as he has been, as he calls it, 'a few moments in the fresh air.' The cocainist is distinguishable by his change of associations, his neglected appearance (of which he seems completely unaware), his dilated pupil, restlessness, hallucinations, illusions and expression of anguish.

"The prognosis is exceedingly unfavorable. It depends in the first degree upon a perfect change of surroundings. The slightest article which could make a cocainist remember some moment of his sufferings is also able to recall the fascination. Even if free for a whole year, he cannot be trusted unless it be in new surroundings. And 'kind friends' are only too willing to remind him of things which he has done and of which he is now ashamed. So that, sooner or later, he will take it again for 'spite' or 'fascination,' or some other reason not to be explained by an uncocainized brain. For women the prognosis is—pessima."

With these words he concludes his account, which, though perhaps inaccurate in certain minor details, seems to me of special value in that it proceeds from a skilled observer, who himself has been behind the scenes and watched the phantasmagoria from the subjective as well as the objective side. It throws also an interpreting light even on the classical descriptions of Erlenmeyer, a summary of which may be found in Hack Tuke's Dictionary of Psychological Medicine, 1892, vol. i, pages 236 and 237. Perhaps, also, the insight thus afforded into the inner workings of an illusionized brain may lead some who have hitherto acted as hard, and even pitiless, critics to recognize something more than "the party's criminal will" in the resultant phenomena. And may all echo the hope that this particular victim at least may find assistance and not hindrance on the dark and troublous road which he is now treading toward a better adjustment of his vital interrelations.—Dr. Springthorpe, in Australasian Medical Gazette; Medical Age.

CHANGE OF AIR—THE SCIENCE OF IT.

By LOUIS ROBINSON, M.D.

ALTHOUGH "change of air" is one of the most generally recognized means of restoring lost health, very little is known as to the reasons why a temporary removal to a new district is frequently of such great benefit to invalids.

That progress has been made on the practical—as distinct from the purely scientific—side of the subject is made plain by the fact that most of the views and customs prevalent among physicians a hundred years ago have now been almost entirely discarded. Better methods of observation and a more exact habit of recording results of treatment—if not more enlightened theories on the physiological effects of change of air—have enabled us to take several considerable steps in the right direction. It seems odd enough to us in the present day that our great-great-grandfathers and their physicians considered sea air to be peculiarly unwholesome, and spoke warningly of its dampness and chilling effects. The air of mountainous regions was looked upon as raw and trying for delicate lungs. In the olden time dwellings were scarcely ever built on an eminence except for purposes of defense, the more favorite sites being those in sheltered valleys. Most of our ancient mansions and farm houses occupy damp and low lying positions, such as no sane modern house builder would think of selecting. English literature tells the same story. From the time of Elizabeth to that of George the Third we find "fruitful vales" and "shady nooks" continually spoken of as the ideal places for human dwellings. Up to the time of the present generation consumptives were ordered to warm and damp regions such as the West Indies or Madeira, because it was thought that phthisis, "the English disease," resulted directly from the harshness of our climate. A very favorite last resort of the eighteenth century physician was to send a patient to visit the place of his birth, since it was thought that "natal air" would be likely to prove peculiarly beneficial. This last theory, although somewhat ludicrous when viewed from our modern standpoint, strikes us as being something more than a mere piece of plausible empiricism. It shows that, in spite of their terrible faith in physic, the doctors of those days did not lose sight of the importance of conforming to Nature's programme.

CLEAN SEA AND MOUNTAIN AIR.

Although the beneficial effect of sea voyages was to some extent recognized, it is easy to understand that the ships of the seventeenth and eighteenth centuries, damp and stuffy below, and provisioned with salt junk and hard biscuits, scarcely gave a broken down invalid a fair chance of deriving any great amount of good from a change of air taken under such conditions.

Generally speaking, we now consider that sea and mountain air owes its virtue to its freedom from organic impurities. Probably it is this quality, more than any other, which gives it its reviving effect on those who have been living in the clogged and polluted atmosphere of large towns. Yet purity of the atmosphere per se is no preventive of those very ailments which bring the majority of patients to seaside watering places and highland sanatoriums. If any invalid who has thus sought relief were to take careful note of the natives of his favorite health resort, he would probably be disquieted to find that pale, sickly children and ailing adults were by no means uncommon. Patients with weak lungs are often sent to winter in Devon and Cornwall, although the mortality from pulmonary diseases among the permanent residents of these favored counties is not a whit less than among the dwellers in the midlands and the north. Yet the undoubted fact remains to be accounted for that such migrants to warmer climes almost always derive marked benefit from the change.

When the late John Addington Symonds first went to live in the searching and rarefied atmosphere of the Engadine, not a few of his friends thought that he was making a fatal mistake, and that he would certainly increase the tendency to phthisis which compelled him to leave England. But since then opinion has so veered round that this Alpine valley has become one of the most orthodox places of refuge for consumptive patients. Latterly certain dry and elevated parts of South Africa and Australia have surpassed it in public favor, because it has been found in many cases that the safety of the patient depends upon his remaining permanently away from the bitter winds of Britain; and the colonies offer greater advantages in the way of occupation than do the Alpine regions of Europe.

NOT A QUESTION OF TEMPERATURE.

It is by no means easy to indicate all the reasons why the air of health resorts such as these proves so beneficial in cases of weakness of the lungs. As we have seen, it is not a question of temperature, as our ancestors imagined; and, although dryness may have something to do with it, we find that our parching east winds are peculiarly trying to sufferers from chest complaints. There can be no doubt, however, that the extreme purity of the air in these regions is an important factor in aiding recovery. Consumption, like all other diseases in which micro-organisms are the chief agents of mischief, is, according to the latest medical philosophy, a strife between the constitutional garrison consisting mainly of phagocytes, or white blood corpuscles, and the invading hordes of the enemy. The various characteristic symptoms which arise in the course of such a malady are so many phases of the combat. Many physicians hold the view that the rash on the skin in such diseases as scarlet fever and measles results from the fact that the skin, as an excretory organ as well as the chief frontier line of the body, is a highly important strategic point, and therefore attracts the combatants of both armies. In the near neighborhood of each tiny coiled sweat gland a deadly strife goes on between the phagocytes and their microscopic antagonists, and the result is a certain amount of redness and irritation of the surrounding tissues. As a rule, the defense and attack are so conducted that the war is prolonged for days or weeks, during which time the forces on each side are nicely balanced. If the invaders can be kept in check in this manner, the disease soon wears itself out, for the micro-organisms cannot stand a long siege, owing to the readiness with which they exhaust the provisions around them. There is also good reason for believing that these living poisons provide their own antidotes, for it is found that in places where they have lived a new material has been developed (probably a waste product excreted by the bacteria themselves) which is inimical to their continued existence. It seldom happens that the human fortress is carried by assault at the first onset; although in some cases of cholera, pneumonia, and in fact nearly all kinds of diseases caused by micro-organisms, such a rapid and fatal termination of an attack may take place within a very short time of the first invasion.

Now, in the air of this thickly populated country it has been abundantly demonstrated that living organisms and disease germs literally swarm. Not only are they set afloat in countless myriads from their breeding places (generally some living fellow creature), but the humidity and temperature of our atmosphere serve to maintain them for some time in a lively condition and possibly to enable them to increase. It is plain that if we can lessen or abolish the influx of reinforcements, the loyal phalanx of phagocytes will have a much better chance of conquering and expelling the foe. One way of bringing this about is the removal of the patient to a climate where the physical wear and tear are somewhat lessened, and where the atmosphere is not only normally free from disease germs, but is inimical to their existence outside the body. All this is fairly comprehensible; but it is evidently not the whole story. There are contiguous regions in South Africa where the air is equally pure, according to physical tests, and yet one proves favorable to consumptive patients and the other rather the reverse.

A VIRTUE IN MERE CHANGE.

This brings us back to the evident fact that there is a peculiar virtue in mere change. It seems to give a fillip to the whole system, and especially to increase the recuperative power. The persistent languor and debility following an exhausting illness, such as an attack of influenza or whooping cough, will often disappear like magic under the influence of a change of abode. Nor is it essential that the patient should go to the seaside, or to some spot of acknowledged salubrity. Often the mere removal from one part of a town to another will result in an immediate and manifest improvement. I know of an instance in which a gentleman, a sufferer from asthma and bronchitis, whose home was in a healthy part of Surrey, obtained very great relief by a short residence among the slums of Seven Dials. Children seem especially benefited by a change of air: so much so that it is often found advisable to remove them even during a severe illness. In two cases which occur to us in which such a course was adopted the little patients had been given up by their medical attendant because they had reached that fatal stage of exhaustion so dreaded by the physician, when all rallying power has ebbed away, and there is no more response to remedial measures. Although it seemed doubtful in both cases whether the children would even survive the journey, an instant improvement took place as soon as the removal was accomplished, and in each case complete recovery followed. Both of these children came from homes where every comfort was provided, and from neighborhoods considered healthful.

We have little doubt that the marvelous vitality of gypsy urchins whom one sees running about clad in an irreducible minimum of raiment in damp and wintry weather, and who are nevertheless as hardy and jolly as young colts, is attributable in a great degree to their constant roving habits. It is well known that wild beasts in traveling menageries, in spite of the rough and limited accommodation which they have to put up with, are more healthy and live longer than those which have all the care which science and money can provide in the zoological gardens. Among the first elephants to breed in captivity were those in Barnum's traveling show, and this almost unprecedented event asserts in the most positive manner that the circumstances under which the animals lived were more conducive to their general well being than those of the elephants in Regent's Park, or even in the government establishments in India. Race horses, it is said, are more likely to become "stale" and to deteriorate in condition when they are kept in one place than when they are traveling

about to different race meetings. Not a few owners of dray horses in London, such as railway carriers, brewers, etc., find it answers their purpose to have a farm in the country, to which the horses are sent for a change when they show signs of failing health.

When we consider how unstable a substance air is, and that on at least six days out of every seven it is continually moving from place to place at the rate of several miles an hour, the difference of character in the atmosphere at neighboring spots, and the constant qualities it maintains at different times in the same locality, are very difficult to explain.

All attempts of chemists to account for these minute aerial differences, which, nevertheless, have so weighty an influence on the bodily health, have hitherto been futile. The chemical composition of air, as far as gaseous inorganic matter is concerned, varies in an extremely slight degree in different localities. Out of doors the proportions of nitrogen, oxygen and argon remain practically constant in all regions, and carbonic acid varies only to the extent of one part in a thousand even when we compare such extremes as the air on a Swiss mountain top and that in the most densely populated cities. The popular notion that sea air owes its vivifying effects to ozone is not sanctioned by science, for, although a certain amount of that much vaunted gas is generally present in the air of seaside places, its action for good on the human frame is more than doubtful. On the whole, too much has been made by writers on hygiene of the deleterious effects of carbonic acid, for as long as this gas remains pure and is unassociated with the deadly carbonic oxide, or "choke damp," it does not seem to produce anything like the serious effects which were at one time supposed to follow from breathing it. Only when it is present in such large quantities as to displace the indispensable amount of oxygen does it endanger life.

Such evidence as we have would seem to indicate that the character of the air in most localities is affected in some subtile way by emanations from the soil, from vegetation, and from other animate and inanimate objects, and that this influence soon ceases when the aerial molecules are wafted away from the spot where it originated.

What the nature of the evanescent material may be we are not yet in a position to say, but in most cases it is probably organic. Our delicate sense of smell tells us how full the atmosphere is of extremely attenuated organic matter. Each room, each house, each district has its distinctive odor, which we are continually recognizing again after months or years of absence, and for which it is often impossible to account. How infinitely minute such odoriferous particles may be has been shown by the familiar experiment with a piece of musk. A small portion of this substance has been known to scent the air of a room for many months, without undergoing any appreciable diminution in weight. Nothing seems more likely than that there may be a great number of substances which thus gradually evaporate and impregnate the air without our olfactory apparatus becoming in any way cognizant of them. Considering the well known depressing or exhilarating effect of many substances (chiefly carbon compounds) which are introduced into the lungs in a vaporized or finely divided state, we are inclined to think that the invisible air-borne matters which may so affect us for good or the reverse are chiefly organic in their origin.

But even if these hypotheses were proved correct, we should yet have to explain the physiological side of the question. The reason why mere change has such a stimulating effect on the vital forces must be sought within the body itself. Where the relative purity of the atmosphere in two localities is the same, the effect of change of air may be of the nature of stimulus to the pulmonary excretory apparatus, so that the system is freed from effete and poisonous material which would otherwise remain and prove detrimental to health. If so, it would be comparable to a change of diet, which often stimulates the excretory functions of the alimentary canal, or to one of the numerous drugs wherewith we aid such operations in various parts of the system. And just as one agent of the latter kind is liable to lose its effect if long continued, so the air to which we have become accustomed may cease to provoke efficient function in the lungs. In fact, when the effect of a change of air is compared with the action of certain medicines, many points of resemblance become apparent. In the case of both, the good results hoped for often reveal themselves only after a certain amount of discomfort and constitutional disturbance.

BIOLOGICAL EXPLANATION.

There are certain biological laws which may help us to understand, to some extent, why a change of air is so conducive to the maintenance or the recovery of health. We have learned, since Darwin's great discovery, to seek for the explanation of widely distributed vital phenomena in the distant past rather than in the present.

Without going back to any prehuman being for evidence, we find some suggestive facts in the condition of existence of our primitive ancestors. The discoveries of archæologists have abundantly proved that civilization, and all the customs and traditions which have followed in its train, are mere modern innovations, and occupy but a very small portion of the long history of the human race. The epoch during which man was a savage hunter, with no fixed place of abode, was so incalculably longer than the most extended estimate of historic time that it is impossible to ignore the influence of such a state of existence upon human nature as we find it to-day.

That early man was a wanderer on the face of the earth, like all modern savages who get a precarious livelihood by hunting, is abundantly proved. With the change of the seasons, or as game became scarce in the vicinity of his cave dwelling, he was compelled to migrate from place to place, in search not of change of air, but of bare sustenance. That such habits, prevalent through so long a period, would be likely to leave a lasting impress on every cell and fiber of the human frame is more than probable. And if these were the prevailing conditions of environment during the manufacture, so to speak, of our physical constitution, it seems reasonable to infer that somewhat similar conditions would be those most favorable to the smooth working of the bodily machinery in modern times. It was found that the unfortunate natives of Tasmania, bred among the hills and woods, perished rapidly when removed to a totally different environment on Flinders Island, and the dwarfs which Stanley discovered in the dense and gloomy forests of the Aruwhimi only lived a short time if forced to dwell in a more open and sunny region. If, therefore, a race of nomads, to whom vagrant habits had become a second nature, were compelled to live permanently in one spot, one would expect that some evil consequences would ensue, and that these would be especially liable to show themselves when the general vitality had been lowered by disease. And, conversely, it seems reasonable to conclude that a renewal of the conditions to which the constitution of man was originally adapted contribute to the recovery of a normal state of health.—From the National Review for July, 1896.

A HYGIENIC VIEW OF WOOD PAVING.

THE following communication was made to the Society of Sanitary Engineers and Architects of France by Mr. A. Petsch, engineer for bridges and roads:

The sanitary condition of cities is influenced in an important manner by the care given to the highways and by the nature of the adopted covering. Public opinion takes account of these matters, and the question is often asked if wood paving is a covering consistent with hygienic requirements? In Paris there are about one million square meters of wood paving. On this surface one hundred thousand meters have been laid expressly for the property owners along the river, at a cost of 450,000 francs.

The preference of the people is thus indisputable. Is this fact sufficiently reflected on, and does it not indicate a danger to the public health?

A few pages of a work on wood paving answer partly this question. From the beginning, wood paving has been criticised by certain hygienists, and it is not at all their fault, nor that of the contractors, who willingly make themselves their echo, if the infatuation of the public has not changed into aversion.

In 1872, in the report of the application of science and art to street paving and street cleansing of the metropolis, the general board of health of London, England, declared that wood is a material which ought to be removed for covering streets, as the surface of the roads ought to be impervious. . . . Hygiene is absolutely opposed to its employment, for reasons which the municipality slights in its dangerous ignorance of sanitary science. Wood is porous, is composed of bundles of fibers, it absorbs and retains water and especially putrescible fluids.

In 1878, Dr. Raymond, an inspector of public hygiene in New York, attributed the dreadful havoc made by the yellow fever at that time in New Orleans to the miasma spread by the wood paving.

In 1882 (when there hardly existed any wood paving in Paris) the Review of Hygiene took the ground that the reason of the unhealthfulness of wood paving seems no less than the impregnation of a body as porous as wood through muddy liquid charged with organic matter, the urine of horses and diluted dung. The wood itself also contains a certain quantity of albuminous matter, soluble, very fermentative, and, consequently, dangerous. In addition, one is often blinded by dust formed of fragments of woody fibers and other injurious substances, and ophthalmia is frequently bred by this cause of irritation.

In 1884, at the meeting of the association of English civil engineers, a director of an asphalt company declared that wood paving was excellent for two or three years, but from that time it looked like an old tooth brush and gave off pestilential emanations through the heat of the sun.

Again in the same year, a report, written by a committee of physicians and scientists, was read before an important gathering, which contained the most serious accusations against wood paving. It said that wood ought not to be used for paving with any feeling of security until there is found a means to make it absolutely impervious to humidity and to suppress the dismemberment of its fibers, which conditions are not yet fulfilled.

Dr. Sedgwick Saunders, a physician to the board of health of the city, at the same time recommended sprinkling with antiseptic liquids, and stated as his opinion that wood paving is the most anti-hygienic street covering that man has invented. In certain roads the disinfection ought to be used twice a day, as the organic matters infiltrate into the joints, decompose there and spread unhealthy odors. These and similar arguments are reproduced periodically in terms differing very little, and can be summed up in the following: The wood produces, when dry, a fine dust composed of pulverized fibers, which is carried about in the atmosphere and from there into the respiratory organs. The wood becoming every day more spongy, absorbs the liquids spread on the surface, not only rain water, but water from the household, horse urine, and generally all the impurities of the street. These liquids introduced into the pores of the wood there lodge putrescible matters to which they serve as vehicles. These impure matters penetrate by the opening of these joints to the foundation, where they settle and form a pestilential hearth.

These arguments so often repeated, or drawn up a priori, or supported by probabilities, have never been demonstrated. And what are the facts? There has been an immense and continued development of wood paved surface even in those cities where the attacks have been most violent. Is it blindness on the part of the municipalities or on the part of the population which demands the new paving? At the metropolitan meeting (January, 1894) of engineers of cities and counties of England, all the members were unanimous in considering the contention of the hygienists as absolutely factitious and sentimental (Major Isaacs, engineer of Holborn; Tomkins, engineer of Marylebone; Mason, of St. Martin in the Fields; Bouinois, chief engineer of Liverpool, etc.); and, according to these engineers, if the local complaints sometimes have been raised with reason, they have only been justified through the poor work in paving or bad sprinkling.

In Paris the opinion of the engineers is the same, that is to say, very reassuring. Certain quarters in the west, such as Marbeuf, are almost entirely paved with wood; their sanitary condition has been very satisfactory, and if it is recognized that this condition, superior to that of the east, is due to other causes, it is also to be admitted that the establishment of wood paving has not interfered with the sanitary conditions and has not developed any epidemic.—Translated for Hardwood, from L'Echo Forestier.

THE MANUFACTURE OF TARTARIC ACID.

V. HOLBLING (in Mitt. k. k. Tech. Gew. Museums in Wien,) describes the manufacture of this acid. The source of the tartaric acid of commerce is the juice of the wine grape, in which it occurs in the form of acid potassium tartrate and calcium tartrate. During and after the fermentation of the grape juice, part of the tartrates is deposited on the walls of the tun as argol and part is contained in the sediment known as lees. The lees are used for the manufacture of tartaric acid, either in the moist condition or after being dried. The moist, pasty lees are removed from the tuns into sacks, and pressed. They then contain varying amounts of acid potassium tartrate and calcium tartrate, with some alcohol and higher esters. They are mixed with water and distilled, the distillate yielding the so called lager brandy and wine oil or Cognac oil. The residue, which is used for the manufacture of tartaric acid, contains from 1 to 8 per cent. of that acid. Lees containing a higher percentage of tartaric acid, which only occurs after the first stage of the fermentation, are well pressed and dried, usually by the heat of the sun, and sold as dried wine lees.

To obtain the tartaric acid from the crude materials (argol and wine lees), the only method suitable for technical purposes is the precipitation of the acid potassium tartrate as calcium tartrate and subsequent preparation of the tartaric acid from the latter. The methods of obtaining the calcium tartrate vary according to the nature of the crude material. A suitable method of obtaining it from argol is to mix the argol, preferably in the form of a powder, with water, and boil, after the addition of some hydrochloric acid, the best proportions being 4 to 5 cb. m. of water with 110 to 120 kilos of crude hydrochloric acid (20° to 22° B.) to about 500 kilos of argol. Milk of lime is then added to the boiling mass until it is nearly neutral, when calcium tartrate is precipitated and neutral potassium tartrate and calcium chloride left in solution. The neutral potassium tartrate is decomposed either by boiling with a sufficient quantity of calcium sulphate or by adding calcium chloride solution, an excess of the precipitant being avoided in either case. The small amount of acid potassium tartrate purposely left in the liquid, when treating the latter with milk of lime, is decomposed with pure precipitated calcium carbonate. The object of not adding the milk of lime to the neutral point or in excess is to avoid the precipitation of iron oxide and alumina. The solution must still remain perceptibly acid after the addition of the calcium carbonate. When cooled to about 40° C., the liquid is filtered with the aid of a suction pump, and the residue washed with water. The dark brown filtrate was formerly treated to recover the calcium chloride and potassium sulphate, but owing to the expense of the recovery and purification, it is now a waste product.

In the oldest methods of obtaining calcium tartrate from wine lees the latter were boiled with water and hydrochloric acid, the clear solution removed, and the residue treated with more water. As the extraction was very incomplete, these methods have not been employed for the last thirty years. When filtration of the lees was first attempted it was found that the pores of the filter became clogged, and that even under a pressure of 4 or 5 atmospheres no liquid would pass through. This difficulty was overcome by the process of Dietrich and Schnitzer, in which the albuminoid substances are coagulated by heating for about six hours under a pressure of 4 or 5 atmospheres. This method has been in general use for about thirty years. Wet lees, when thus treated, can be readily filtered. Dried lees are crushed, stirred in a tank with water, and heated by steam for some time, until air is completely expelled, before being heated in the pressure boiler. According to the author's experience, preliminary boiling for more than half an hour is superfluous.

Dietrich and Schnitzer's pressure boiler consists of a tightly covered wrought iron cylinder, with a manhole and charging opening in the cover, through which passes a copper steam tube with a worm at the bottom, and having small openings at the top of the bend, so that the steam is regularly distributed throughout the entire mass. There is also a tube of copper, through which the lees are forced when the heating is finished. The dimensions of an average sized cylinder, holding about 1,500 kilos of lees, are 4 m. in length and about 1·4 m. in diameter. The tubes, which are of copper, and the interior of the boiler, require constant inspection to avoid the danger of an explosion, and every six months the boiler is subjected to a pressure test one and one-half times in excess of the maximum normal pressure, since the iron is rapidly corroded. To avoid this danger, and to obviate the drawback of having a considerable amount of iron taken up, which is troublesome in the further stages of the manufacture, experiments have been made to find a substitute for iron as the material for the boiler. Copper is undoubtedly the most suitable metal, but its high price, and the fact that it is not absolutely unattacked, have stood in the way of its adoption. Lining the interior of the cylinder with lead is useless, since the metal is rapidly attacked by the sulphureted hydrogen liberated from the heated albuminoid matters, and rapidly peels off. The most effective means of protecting the iron is to line the boiler with cement. The most suitable dimensions for a boiler intended to be thus lined are 2 m. in diameter and 2 m. in height.

During the process of heating the lees, the steam passing from the apparatus carries with it volatile empyreumatic products derived from the decomposed albuminoids. These have a very offensive odor, and should be conveyed into a factory chimney of sufficient height, so that the evil-smelling vapors are drawn up and decomposed by the furnace gases.

When the heating is finished, the steam outlet pipe is opened and the pressure allowed to fall from 1 to ½ atmosphere, this pressure being required to force the lees from the boiler into a tank, which may be suitably constructed of wood. Here they are mixed with water, which has previously been put into the tank, and the requisite quantity of crude hydrochloric acid (21° to 22° B.) Experience has shown that for every 100 parts by

weight of argol in the lees, 100 parts of acid are required. Too little acid causes decomposition of argol in the cloths of the filter press, while too much destroys the cloths, and more lime is required to neutralize the filtrate. If the conditions are right, the filtered liquid should have a specific gravity of about 6° B.

The acidified lees are pressed and washed, the washings being used instead of pure water for mixing with the next charge of lees from the pressure boiler. The tartaric acid in the filtrate is precipitated with lime and calcium carbonate, and the remainder of the process is the same as in the case of argol, with the exception that there is no necessity to add calcium chloride or calcium sulphate.

The calcium tartrate obtained from wine lees is of a clear gray color, and considerably purer than the dark gray or dark brown product from argol.—Jour. Soc. Chem. Ind.

MODELS OF THE UNITED STATES.

By Cosmos Mindeleff.

Renewed attention has been attracted to the project of making a huge ground map of the United States at Washington, by the report of Representative Quigg of New York, of the library committee, on a resolution which has already passed the Senate. This resolution provides for the appointment of a commission of five to examine into the project and report upon its practicability.

Few persons, aside from those having a technical knowledge of the subject, have any idea of what geographic knowledge is available, or of the methods by which maps can be converted into models; and it seems that not even those who originated and are most interested in the project have considered its cost. They have apparently failed to realize what an immense country this is.

RELIEF MAP OF THE UNITED STATES.

From Butler's Complete Geography, copyrighted 1887. Used by permission of the publishers, E. H. Butler & Co., Philadelphia.

The greatest diameter of the United States is about 3,000 miles; that is, an area laid out on the ground for a map would have to provide space to that extent. The north and south diameter is about 1,900 miles, making a total of 5,700,000 square miles which must be shown on the model. The plan now under consideration provides for a scale of a square yard to a square mile, which is three feet to one mile; this would make a model over a mile and a half long and over a mile wide, a total of 51,300,000 square feet or 5,700,000 square yards of ground surface to be modeled. If the relief were shown on the natural scale, without vertical exaggeration, the highest mountains of the United States would rise about nine feet above sea level, while the Grand Canyon of the Colorado would be a gorge over three feet deep. In the eastern half of the model the greatest elevation would be less than three feet.

Some time ago, Mr. Henry Gannett, chief geographer of the United States Geological Survey, published a paper on mother maps. Mother maps, he explained, were those made from original data, and were the sources from which commercial and other maps were compiled. In connection with his subject he went into the question of available data or knowledge extant concerning the geography of the United States, and the largest scale upon which such data could be shown. Assuming that a map should be accurate upon the scale to which it is drawn, that is to the twentieth or the thirtieth of an inch on paper, he showed that there are considerable portions of this country about which we know so little that we would hardly be justified in mapping them on a scale of sixteen miles to one inch, which is the scale of many of the Land Office maps.

Supposing that the data did justify the sixteen miles to one inch scale and no more, this would mean that we know the location of every town and village, every railroad, and in fact every point in the United States within half a mile of its true position. There are many points which we know to within a hundred feet, some that we can locate with a possible error of only a few feet, but to be able to locate every point in the country with a possible error of only half a mile would be an immense advance over our present knowledge.

If we translate the data from a paper map to a model on the scale proposed, the most painstaking care could not make it accurate nearer than a foot and a half for many parts of the country, and in practice it would be found necessary to set the limit at three feet or more, rather than eighteen inches. Moreover, to make the ground map accurate to within a limit of eighteen inches would require such an immense amount of office work in the compilation of data that the expense would be prohibitory. Further, if the huge model were made with the same fidelity to the maps which is demanded in smaller ones, supposing the data by some miracle to have been secured, the cost would be almost incredible. Models of small areas which have been made for the scientific bureaus of the government (notably the Geological Survey and the Coast Survey), and for publishers and for other private purposes, have cost from $10 to $50 a square foot, generally the latter. Were a model of the United States made in the same way on the scale proposed, it would cost, at the lowest rate, $500,000,000.

It would be impossible, therefore, to make a model of the size proposed, if the same degree of accuracy were required that is demanded in small examples. But if the commission, understanding this impossibility, and some other limitations inherent in the subject, allow a reasonable limit of error, a wonderful and extremely valuable work might be turned out; one that would add much to the attractiveness of Washington, especially to visitors.

The principal element in maps which purport to illustrate a country is the relief. This is usually shown in one of two ways, either by hachures or shading, or by contours. Both methods are strongly advocated by their partisans, and both are in a measure unsatisfactory for general purposes. Where the quantity of the relief is to be shown, resort must be had to contours, but in this system the graphic element is almost entirely lost. Where quality of relief is the principal desiderata, and the quantity is a secondary question, hachures are employed. One is a quantitative, the other a qualitative system. The engineer demands contoured maps, the army prefers hachured ones.

In hachured maps the relief is shown by shading with small lines, and in the best examples an effort is made to show the actual hills, mountains and valleys as they would appear under given conditions; that is, with the light striking the surface of the earth at a given angle. The best example known of this class of work is the Dufour map of the Alps.

In the contour system the relief is shown by a number of continuous lines at given distances above mean sea level or some other datum point. In other words, were the sea to rise to a given height, the contour line at that height shows where the coast would be. This system, which is much more accurate and definite than the other, is now coming into general use and superseding hachures. The principal objection to it is the loss of the graphic element, before mentioned, which makes contoured maps difficult to understand; and it is no exaggeration to say that not one person in ten thousand of the general public can obtain a fair idea of the relief of a country from the study of a contoured map of it.

Here is where the model comes in. It can be made fully as accurate as a map, but besides this it is an actual picture, a duplicate in miniature, which can be understood by any one. And aside from its simplicity, it is often of the greatest use to the geologist and the engineer, to the irrigator and the railroad constructor, for by its means they can obtain a better general idea of a region than they could by the study of any number of maps, or even by an examination of the region itself; they can see the whole country, as it were, at one glance. The value of models in conveying an idea of a region or country to a person who knows nothing of it, and especially to students, is obvious.

The making of models is generally an elaborate and costly process. The prime requisite, aside from skill on the part of the modeler, is a good contoured map. In addition, the modeler must possess some knowledge of the region to be represented, or failing that, some general knowledge derived from his experience and acquaintance with similar regions. It has been said that any one can make a model, and this is quite true; but only in the same sense that any one can draw; there is a vast difference in the finished product. A model can be made quite as much a work of art as a portrait, for it is in fact, or seeks to be, a portrait of a country.

The contoured map which is to form the basis of the model is enlarged or reduced to the required scale, and each contour upon it is transferred to thin sheets of wood or cardboard of the exact thickness required by the vertical scale. They are then sawed out with a scroll saw and tacked or glued upon a base board in their proper relations one to another. When this work is completed the model is a copy of the contoured map, but with the contours in relief, rising in a series of steps from the seacoast to the highest points. Up to this point the work is mechanical in nature and can be done by any ordinarily careful workman.

Here the work of the skilled modeler commences. Upon the raised contours as a base he sketches in the principal features of the relief with modeling wax and then proceeds to fill in such details as his scale will permit. In this process the raised contours are entirely covered up and the finished model has a continuous surface, a copy of the region represented. To any one at all familiar with contoured maps it is apparent that the modeler must supply much data which was omitted from the map; he must undo, as it were, the generalizing which produced the map, and supply those details which, omitted from the map for the sake of clearness and brevity, are still from the artistic standpoint of the greatest importance. It is these details largely which give a region its individuality and expression, and they must be shown in the model, otherwise it will be wooden and expressionless. The contours show only a selected portion of the country, only those parts which are intersected by a series of horizontal planes at equal distances apart; but the model must show all of the country, the portions between the contours as well as the others.

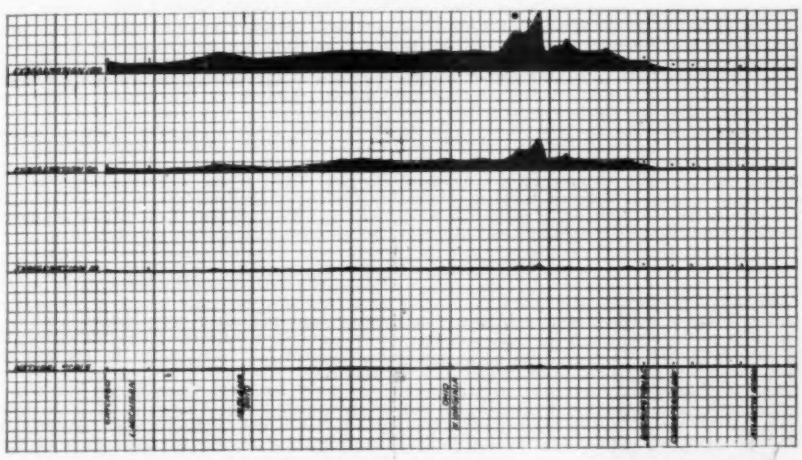
The raised contours of the model are merely a means of control, a check on the modeler. They occupy to the finished model much the same relation that a primary triangulation does to the finished map. A perfect modeler, if that variety should ever be evolved, would be able to make a model without them. Often the contour interval is very small; on a model of the United States about three feet long, with a vertical scale of 40,000 feet to 1 inch, the 1,000 foot contours would be used, and each of them would be one-fortieth of an inch thick. With such an interval the modeler could not go far wrong.

Sometimes the wax model is used in that condition,

but usually a plaster mould is taken from it, and in this a cast is made of plaster or some composition. The cast can be painted and lettered to show such data as may be desired. One of the advantages of this method is that, should a cast be injured in transportation or otherwise, it can be replaced quickly and at small cost so long as the mould is preserved. Moreover, several casts can be made to show different classes of data, and for this purpose they are often more valuable than a corresponding series of maps would be.

Aside from the amount or degree of accuracy required in the model, or the limit of error to be permitted, four important questions will confront the commission at the very outset. The first thing for them to decide will be, Shall the model be constructed on a flat base, or shall it show the actual curvature of the earth? Then geographic knowledge is so extensive that they will be compelled in the beginning to decide what data the model shall exhibit and what can be omitted with advantage. The relief of the country must in any case be shown, else there would be no reason for making the model; and when the commission get this far in their work, troubles will come thick and fast upon them, for they will have to decide how much vertical exaggeration to use. Concerning this question there has been much controversy among geologists and topographers, and hardly two men think alike. While we do not hear much about it now, the controversy is not dead, but sleeping. Finally a decision must be reached on the material to be employed and the method and degree of finish.

The region of the United States occupies no inconsiderable portion of the earth's surface; few people realize that its greatest diameter is one-eighth of the circumference of the globe. This means that the curvature of the earth would be pronounced on a large scale model such as that proposed. Were it possible to take out that section of the earth's crust which we call the United States, as we might remove a section of orange peel, and set it down on a plane surface with its four corners touching that surface, the section would rise in the middle, or be bulged out, about 480 miles. Were the model made to represent nature, and without vertical exaggeration, it would require to be bulged or rise from the flat 1,440 ft. on the scale proposed. With vertical exaggeration the center would rise higher than that, according to the degree of exaggeration. The question would be, Shall the model be made on such a base, the segment of a sphere 24,000 ft. in diameter? Shall the sphere be made smaller to emphasize the curvature of the earth and correspond to the vertical scale, or shall the relief be shown on a flat base?



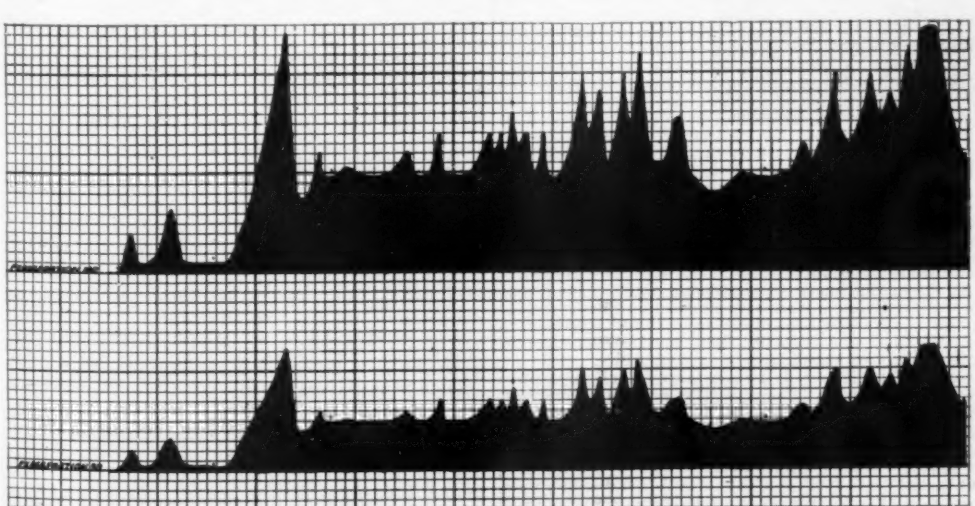
PROFILE OF THE EASTERN UNITED STATES, SHOWING EFFECT OF EXAGGERATIONS OF VERTICAL SCALE.

The illustration here given shows a model of the United States made for the U. S. Geological Survey, in 1893, by E. E. Howell, and exhibited at the World's Fair. The model cost $1,000, and a year was allowed for the making, but the time was afterward extended several months. The original, which is about 7 ft. wide, was made on a scale of 40 miles to 1 inch, with the vertical scale exaggerated five times (1 inch to 8 miles), while the curved base upon which the relief is shown represents a section of a sphere 16½ ft. in diameter. We have, therefore, three different scales upon the model, a thing much to be deplored, for nature never has but one, and the farther we depart from nature, the less truthful is the representation.

While the primary function of a model is to illustrate the relief of a country, so many other things are intimately connected with the relief that but a small percentage of them can be shown. It will be necessary to decide, therefore, what must be shown and what can be dispensed with, and as in the mind of each specialist his own subject is apt to be considered of dominating importance, it will be no small task to decide between them. The consideration of this problem alone might easily consume several months.

The amount of exaggeration to be given the vertical scale, as compared with the horizontal, will be the most important question that will come before the commission, and the most difficult to decide. Yet a proper decision is essential to the success of the work, and an error of judgment, which would make the whole model a failure, could not be corrected except by doing the work over again. The problem is especially difficult because only an expert modeler can tell beforehand, even approximately, what the effects of various scales and proportions of scales would be, and such modelers are very few. Aside from such experts, not one man in a thousand among geologists, topographers and engineers can form a fair conception of the picture the finished work will present.

It is not surprising, therefore, that many and bitter controversies have occurred over questions of vertical exaggeration. Some of its strongest opponents have gone to the length of saying that no vertical exaggeration is necessary, that all such exaggeration is false; and one prominent geologist has stated in print his opinion that "he that will exaggerate the scale of anything will lie." There is much in this; undoubtedly vertical exaggeration is in a sense a lie; yet there are two kinds of fidelity to nature, truthfulness of detail and truthfulness of general effect. This is illustrated by the Muybridge series of photographs of moving animals which were made a decade or so ago. For centuries artists have been depicting horses in motion with a truthfulness and fidelity to nature which was never questioned. Yet a series of instantaneous photographs of a horse in motion, made at intervals of a small fraction of a second, showed that at no time did the feet of a horse occupy the positions seen in paintings and drawings; but, on the contrary, the movement was entirely different. Soon after these photographs were made, some illustrators used the facts developed by them and produced pictures of horses in motion, which, while as near to absolute truth as human effort could make them, were absurd and fantastic, and in general effect wholly false.



PROFILE OF THE WESTERN UNITED STATES, SHOWING EFFECT OF EXAGGERATIONS OF VERTICAL SCALE.

So it is with models. Absolute fidelity to detail will sometimes give a result which, while accurate, has no meaning; it will not be in any sense a picture of the country. The modeler should be an artist, for that indefinable something which gives a picture its value must be in the model, else it will not represent truly its subject.

The primary effect of vertical exaggeration is to increase the angle of slope, the proportionate width of the valleys is diminished, and the country is made to appear more rugged and mountainous than it really is. But a secondary effect, of even more importance, is to reduce the apparent size of the country. The human mind receives and digests its impressions in a certain way, and to the extent that we depart from nature we do violence to these impressions. Under heavy vertical exaggeration a country represented by a model looks small. We may know the dimensions and be able to state the area shown, the heights of the mountains, the widths of the valleys; but we cannot obtain other than a false impression of the extent of the region. Even in the models of the United States which are illustrated here, and on which the vertical exaggeration is comparatively small, this is apparent. Would any one, ignorant of the topography of the country, ever obtain from a study of the models an adequate conception of the extent of the great valley of California? And would he realize that on the traveler that valley produces much the same effect as the plains of Kansas?

On the other hand, some vertical exaggeration is necessary on small scale models or there will be nothing to show. Were the area of the United States modeled on a globe 1,000 ft. in diameter, the greatest relief would be but little over four inches, while most of the mountain country east of the Mississippi would be less than 1 in. above sea level. One inch in three thousand feet, the approximate circumference of such a globe, would hardly be perceptible.

The flat model which is shown has a vertical scale of 40,000 ft. to 1 in., being an exaggeration of ten. One-fortieth of an inch to 1,000 ft. seems very small, but it sufficed to show the principal features of the country, notwithstanding that the maximum relief was only about one-third of an inch in an area measuring about 2 by 3 ft., and that this is merely a sketch model. It was made by the writer in a few weeks, and cost but $100.

It will be no small task to decide on the proper vertical scale to give the model, for a hundred minor questions, other than those indicated, will enter into the problem. Something will depend on who will do the modeling, for a good modeler can bring out the salient features of the relief on half the scale that another would require. Much also will depend upon the amount available for the work, for close modeling, necessitated by a small vertical scale, is very much more expensive than rough sketchy work.

The material to be employed in the work is another perplexing question which must be decided before work can be commenced. Such a model cannot be made of earth if it is designed to last more than a few months, nor can the materials usually employed in models be used. Probably resort will be had to cement or asphalt; but an asphalt pavement costs over $2 a square yard, and cement would cost more. Allowing but $1 a square yard, this would make a total of over $5,000,000 for the material employed merely in surfacing the model. Were the contours built up in wood, as they must be for good work, the first one alone would require over 200,000,000 ft. of lumber, board measure. At least thirteen contours would have to be put in place, gradually diminishing in area as they arose, and it would not be safe to estimate for less than 1,000,000,000 ft. of timber for this preliminary work. The material in the model, including lumber, surface coating, and everything else, would cost not less than $30,000,000. Assuming that the modeling could be done for 50 cents a square foot, instead of $50, this item would require $25,000,000, in addition to the cost of collecting and preparing data, supervision of the work, etc. An estimate of $75,000,000 for the completed work would be very conservative.

While the scheme proposed by the resolution of Congress is not practicable, it may be so modified that it can be carried out. If this is done, a wonderfully effective and extremely valuable work might be produced. To accomplish this it will only be necessary to reduce the scale, and to make a model which should be exhibited under cover, instead of in the open air.

A model of the United States, 100 ft. in diameter, would be quite as effective as the great ground map proposed; even more so, for in the smaller work it would be possible to see the whole subject at one glance. A model of that size could be made, with careful attention to detail, for the scale would be nearly 3 miles to 1 in., with a necessary limit of error of less than one-quarter of an inch. A skillful modeler might be able to make it without vertical exaggeration, as there would be an inch of relief on the natural scale, and elevations of 500 ft. could be shown. On a curved base such a model would rise 16 ft. above the flat. The total cost of such a work, of infinitely better quality than the large model proposed, would be less than $50,000.

RUINS OF THE GREAT ZIMBABYE.

THE ruins of the Great Zimbabye, in South Africa, have been described several times already, and, since they were made known in 1871 by the German explorer Carl Mauch, have attracted much attention from archæologists and scientists; for one theory, which is at least very defensible, sees therein a proof of an ancient Phenician occupation in these remote lands, which, but yesterday almost unknown, are now dependents upon Chartered.

The opportunity is not offered to everybody to visit Mashonaland, between the Limpopo and Zambesi, at about ten days' journey to the north of Johannesburg. Few persons, therefore, have seen these structures themselves, and, on another hand, we do not believe that they have been represented in any French work; so we have thought that it would be of interest to offer in this place the accompanying engraving.

Let us begin by briefly describing the ruins themselves, and then examine the origin that is ascribed to them.

The ancient structures of South Africa are found in what of old was called Monomotapa, a country which the Portuguese certainly entered as long ago as the beginning of the 16th century, and in which the existence of these strange ruins, as well as that of the neighboring gold mines, must have at once attracted the attention of their explorers.

The principal structure is that of the Great Zimbabye, which is situated at about twenty-five miles from Fort Victoria, upon the east bank of the Sabia, at an altitude of 3,300 feet. Here, upon a granitic plain, the simple erosion of which has produced ruin-shaped blocks that have given rise to some very fanciful interpretations, there are two distinct edifices—to the north a sort of fortress, qualified by the traveler Bent as an acropolis, and to the south a wide elliptical inclosure surmounted by two conical towers. Both are built in the same way of roughly squared granite arranged in superposed courses without cement.

The acropolis is upon a rock, which, toward the south, presents a declivity eighty feet in height. At the very top of the summit stand blocks of from forty to fifty feet, and pillars of clay more than ten feet in height, covered with geometrical designs. Beneath there is a platform where Mr. Bent sees the site of a temple, altar, etc., and where stand eight pillars surmounted by very conventional figures of birds, some of them five feet in height. Excavations have brought to light here the shapeless remains of pottery and vessels, one of which bears a design representing a Hottentot leading three zebras and a hippopotamus. Besides, what is particularly important, beneath what is called the temple there has been discovered a miner's furnace of extremely hard cement, with small clay crucibles that have been used for the smelting of gold and that contain particles of that metal still adherent, some tools, a steatite ingot mould, etc.

A prospector, who has examined these ruins with care, tells us that he has seen residue of auriferous quartz at more than one point.

The elliptical inclosure is separated from the acropolis by a small valley. It is 250 feet in length in the direction of its larger axis and forms a platform surrounded by a granite wall more than 15 feet wide at the base, with a maximum height of 36 feet, in which, toward the north, open three small gates one yard in width. In this wall, to the southwest, there is an ornamental band in which it is claimed that the sign of Aquarius has been recognized. Great equidistant blocks of stone, of strange appearance, stand above.

The interior of the inclosure is an inextricable labyrinth, in which we remark only a narrow passage between two walls over thirty feet in height, and two conical towers, which, it seems, are absolutely solid (due to a falling in) in the interior, without any visible trace of a stairway. It seems to us that this renders it probable that we have to do here with a religious symbol.

It is one of these towers that is represented in our engraving. It is probably about fifteen feet in height, and it is certain that its form, which is that of a truncated cone, and its mode of construction present some analogy with the famous nouraghes of Sardinia (especially with that of Zuri, near Abbasanta), or with the talayots of the Balearic Islands, the origin of which has been ascribed to the Phenicians.

From the general study of these Sardinian structures made by Mr. Perrot a few years ago, it appears that they were very likely true fortresses, and it may be remarked that in several of them, or in their immediate vicinity, there have been found bronze smelters' workshops, just as at Zimbabye a gold smelter's workshop has been discovered. But the Zimbabye structure does not exhibit a characteristic enough type to allow us to attribute very great importance to such a comparison. It may occur to any individual who has to defend himself to construct such a tower with the blocks of stone that he finds within his reach, without, for that reason, having any connections of origin or relationship with the people who constructed the nouraghes. A little skepticism would therefore appear natural in such a matter if historic documents did not afford some interesting arguments in favor of the very ancient origin of the ruins of Zimbabye.

At the beginning of the sixteenth century, for example, a Portuguese author named Joao de Barros speaks of the ruins of Zimbaoe, and says that, according to the Moors of the country, they were constructed in order to protect the neighboring gold mines.

So, too, in 1656, we find in a large Dutch atlas published by Joannes Jansonius, the names of Zimbaos, Buro and Manica, accompanied with these words: "ubi est auri fodina," "where there are gold diggings." And the text adds: "The King of Butua, a country rich in gold mines, is a subject of Monomotapa (Transvaal). Here is seen a large house called Zimbal, of square shape, of wonderful size, and constructed of very large stones."

Whatever be the epoch at which the edifices of Zimbabye were constructed, there is one point nearly demonstrated, and that is their relation with the auriferous exploitations of the vicinity.

A knowledge of the gold deposits of South Africa (not in the Transvaal properly so called, but in its northern part, particularly in the country of Manica that the English, by reason of its presumed richness, have recently thought it their duty to take away from the Portuguese) had, as we have just seen, reached Europe as early as the sixteenth century, and we may say that it has never been lost, although, in the present century, there was at first a tendency to believe such deposits legendary.

We possess, in particular, a very old document, dated 1768, in which there is a question of them. It is a manuscript collection of memoirs of which we shall some day publish some fragments. In one of these memoirs the author, Mr. De Maudave, a gentleman of Dauphiny, who had become a colonist on the Island of France, mentions by the way, exactly as we might do to-day, the importance that Madagascar may present from the view point of commercial relations with the neighboring African coast, especially with that capital position of the Bay of Delagoa, where a thorough examination of the celebrated periplus of Hanno seems to show that the Phenicians may have arrived as long ago as the time of Herodotus, and which ere long will certainly be the great port of entire South Africa, and, at the same time, the principal point of access toward the entire interior.

Another object, says he, not less essential to our establishment at Madagascar is the facility of creating and extending new branches of commerce upon the east coast of Africa, from the land of Natal as far as to the Cape of Guardafui. The bay of Lagoa, into which discharges itself a large river that comes from the interior, merits being better known and more frequented. Here are exchanged linens and ginghams for gold, ivory and slaves. At the Cape of Good Hope I saw some of these slaves. They were strong and robust and appeared to be less stupid than the other Caffres. The rest of this portion of the coast of Africa contains several rich and populous cities where it is possible to trade with advantage. Such are Melinda, Monbaza, Soffala, Quilloa, Sena, Mozambique, etc. In the first of these cities the Arabs are the dominant people. They trade with the negroes of the interior as far as to Monomotapa and obtain much gold from them. Although the Portuguese claim everything in this part of Africa, their destitution and weakness give wide scope to interlopers. There is scarcely any Portuguese governor in this quarter whose good will cannot be bought with shirts and a few pairs of stockings. It is certain that the east coast of Africa is gorged with riches and that it is very practicable to establish a most lucrative business there. The establishment of Madagascar will obtain for us all the facilities desirable.

As may be seen, there is, as has often been said, nothing new under the sun. It is possible that the ancient Phenicians knew, many years before Christ, the speculations upon the gold mines of South Africa; and, as long ago as the last century, this Mr. De Maudave, a precursor in matters of colonial enterprise, pointed out the commercial importance of Madagascar, as well as the close tie that unites this country with South Africa, in assuring, at the same time, its prosperity.—L. De Launay, in La Nature.

RUINS OF THE GREAT ZIMBABYE, IN SOUTH AFRICA.

TRANSMUTATION IN MINERALS—GEMS MANUFACTURED FROM THE NATURAL CONSTITUENTS.*

THE alterations in minerals occurring in nature can be explained on chemical grounds generally; and by experiment we have reached the point, in some cases, of producing the same alterations exactly in the laboratory.

Pyroxene, a mineral very common in eruptive rocks, is often found changing in nature into another mineral called hornblende, of very much the same composition.

Heat pyroxene nearly to redness in water under pressure, and the surface gradually changes into hornblende. This is closely analogous to the operation in nature—the action of water at very high temperatures on pyroxene changing it into hornblende.

Immerse a crystal of hornblende awhile in an infusion of pyroxene, the hornblende changes back into pyroxene.

The foregoing and like experiments are valuable aids to the geologist in determining the character of natural changes in rock structure.

In subterranean rocks, 20,000 to 30,000 feet deep, water at enormously high temperatures (still fluid owing to pressure) changes minerals from their original conditions into other compounds. All of the minerals that solidify from fusion in eruptive rocks will be altered by the action of water in this way into other compounds.

The action of water under pressure at slightly lower temperature will produce a mica from the hornblende; so from the original pyroxene we can have first the hornblende and then mica. If the mica be exposed to the action of water at the surface, it will change into clay or into kaolin. All these changes have been produced artificially in the laboratory.

If pyroxene melts at 1,200° Centigrade, it will probably remain liquid, when once melted, down to 1,150°. That fact is used in producing artificial crystallization of these minerals direct from fusion; but if we attempt to fuse a garnet down and crystallize it, it immediately decomposes into two or three other compounds, and we get not garnet, but a mixture of several minerals.

Dissolve a garnet at a temperature lower than decomposing point, and it will crystallize.

Heat feldspar for a long time in water (under pressure) a little above the boiling point. The change from feldspar into kaolin takes place in the solution.

Some of the laboratory experiments in the formation of minerals have been carried on continuously for eight months on one specimen.

The formation of minerals artificially may be the result of design or purely accidental. Furnaces making pig iron turn out a by-product, a slag or cinder containing the earthy parts of the ore—the lime, alumina and silica. This slag, when cooled slowly, crystallizes into the form of a very pretty mineral.

The slag from the old William Penn furnaces, on the Schuylkill River, near Spring Mill, are almost all crystallized, wherever there is a chance for crystallization on a free surface. They have the form and composition of a natural mineral which crystallizes from lava and is not at all uncommon in Vesuvian lava.

The attempt to form artificial minerals has only in the last twenty years been taken up with any great thoroughness, in which time a special work on the subject has been published.

It has been found possible by running together the constituents of certain volcanic rocks to obtain artificially all the minerals in those rocks, and on quite a small scale (working sometimes with only two ounces of material) get specimens of the rock which are crys-

* Condensed from a lecture by Prof. Amos P. Brown, of Philadelphia Academy of Natural Sciences.

tallized and have every appearance of the natural mineral.

The artificial formation of minerals was first attempted nearly a century ago by Sir James Hall, of England, who melted down a large number of rocks in his vicinity and attempted by slow cooling to make these rocks form in the condition of volcanic lava.

A century ago geologists were divided into two schools—the "Plutonists," who believed that almost all rocks were the result of eruptive fire; and the "Neptunists," who attributed them to aqueous action. A great many of the rocks now known to be of igneous origin were claimed by the geologists to have been formed from deposits from the water.

The use of the microscope and the oxyhydrogen blowpipe on fine fragments of minerals was unknown a century ago; so that while Sir James Hall did succeed in making fine grained rock, he did not discover it; and it was not discovered to be complete until fifteen years ago, when they were found to be of the characters he imagined they would turn out to be.

A great many of the experiments at mineral building were simple attempts to crystallize by fusion; others were carried out by action of chemical agents—gases, vapors of various kinds, or solutions—upon solid substances; and especially the action at high temperatures of water in closed tubes.

Where these closed tubes were originally of glass, they are now of soft steel lined with either gold or platinum to avoid corrosion; so that the water under pressure in these tubes is made as hot as an ordinary fire, under which circumstances its solvent action is enormously increased.

In these artificial formations of minerals, the broadest distinction must be made between the purely chemical synthesis and the mineral synthesis. It is perfectly possible, by melting together the constituents of ordinary feldspar—that is, silica and alumina and sodium carbonate or potash—to obtain a glass of exactly the same composition of feldspar; but that glass is in no sense feldspar.

Feldspar is a substance which crystallizes and has a definite structure, entirely different mechanically from the glass which chemically corresponds. This glass would be much softer than the natural orthoclase (common feldspar) and much lighter; would melt at a lower temperature and, of course, would have no crystalline structure—would be entirely amorphous. Orthoclase cannot be made by direct heat, so that all attempts to form a mineral from melting its constituents would simply produce a glass.

If this same mixture of constituents had been placed in one of these steel tubes and heated with water under pressure, then the reaction would have taken place, producing crystals of the feldspar.

Precipitate the lead sulphide chemically, it goes down in fine powder. Now take that same sulphide and treat it under pressure in the presence of sodium sulphide, or heat it and subject it to the action of hydrogen sulphide or some other gases which act on it—then we would get cubical crystals of the mineral galenite. As soon as we get crystals of the same structure as galena we have the mineral galenite.

In order to carry out these operations in a laboratory, blast furnaces are generally employed—a gas flame driven by an air blast which is supplied by a water blower. It is found that all temperatures, up to the melting point of steel or wrought iron, may be controlled very closely when produced by a gas flame.

The minerals to be melted are usually placed in platinum crucibles, and the temperature of fusion of the mineral desired carefully observed, and that temperature, or a little below it, kept in the furnace. In this way Fouquier and his colleague produced finely crystallized rocks exactly like those from nature.

Garnets, as they occur in nature, have never been formed under the conditions of fusion in laboratories. Garnet is not a mineral solidified at the surface, but underground, under a heavy pressure; or has been altered from another mineral after it has been solidified.

In attempts to make artificial gem stones by chemical processes, unless the gem is one of great value, it will not pay to produce it at a price to compete with the natural gem. Gems of the type of the garnet or topaz, whose principal value lies in the cutting, would not be formed to advantage, although probably all could be formed with the colors as found in nature.

The ruby, weight for weight, is much more valuable than any other gem—four or five times the value of a diamond, if it be a large one.

The gem chrysoberyl is an aluminate of beryllium. By heating together the fluorides of aluminum and beryllium in the presence of boracic acid, large crystals of chrysoberyl may be procured—generally, nearly colorless, however. Chrysoberyl, in the mineral known as alexandrite, is an emerald green stone, which very often shows a ruddy complexion, and is highly prized. That has been, thus far, not imitated; but, probably, by adding a little chromium, which seems to be the coloring matter, the natural gem could be produced in its own color artificially.

Ruby making has been much more successful, is now done on a large scale, and artificial rubies made in this way compete with the natural gem, and are fully equal—very much better in the respect that they are not liable to contain flaws.

The ruby is the oxide of aluminum. It is well crystallized, and colored with a little chromium. Chromium is the coloring matter of a great many of the gems.

By heating together aluminum oxide and silica (quartz) ground up, or, as a flux to dissolve these two substances, a fluoride of barium, and then adding a little bit of ordinary potash bicromate, it has been found possible to produce crystals of rose colored ruby.

The crystals of ruby formed by this building process depend entirely upon the length of time the melting of the constituents is kept up.

Five hundred pounds of ruby constituents, kept under prolonged fusion, produced rubies of 5 or 6 carats, which varied very much in color—running through all shades of bluish sapphire color (sapphire, by the way, is the same material), rose color, and the deep, so-called pigeon blood ruby, which is the highest priced ruby.

The artificial gems can readily be distinguished from the natural by examination under the microscope.

The natural gem contains minute cracks, as seen with the microscope. Even though it seems to be entirely flawless, careful examination with a microscope of 100 diameters will show minute cleavage cracks running through the gem. The artificial gem contains nothing of this sort, but shows very minute bubbles or gas holes. So far as the luster and hardness are concerned, the artificial stone is exactly like the natural; and no one could tell the difference, except by this particular test.

Taking ordinary borax and fusing it with alumina and a little chromium oxide (used for coloring bank notes) we may obtain rubies in quite large crystals, if fusion is continued for a week or so. This is not a cheap product, and 200 pounds may produce only two or three gems of any value; therefore, while the artificial gems can be made to compete with the natural gems, especially if they are large, it is not a very paying process on the whole and not likely to greatly lower the cost of natural gems from the present outlook. It is quite possible that cheaper methods of heating may be obtained by the use of electric furnaces, where the temperature can be maintained higher and more uniform than at present. So far as the use of the artificial gem is concerned, it is absolutely as good as the natural.

Within the last three years successful attempts have been made to produce diamonds artificially.

The diamond (at least carbon of that hardness) has been made by acting on iron containing 4 or 5 per cent. in carbon—decomposing the iron by means of sulphur under pressure. This is done in closed steel crucibles; a block of steel bored out, with a tightly fitting cap clamped fast with screw clamps, was filled with a mixture of this iron (high in carbon) and sulphur, and then subjected to heating up to the boiling point of sulphur; sometimes as high as low red heat. The iron combines with sulphur into sulphide of iron, and the carbon which was in the iron is set free. A small percentage of this carbon, under these conditions, forms as black diamond, known in the trade as carbonado.

The only purpose to which carbonado (artificial black diamond) could be put is grinding or boring; this, therefore is probably not the method which could be used for the production of gems.

The cheapest and best process of making white diamonds consists in melting in an electric furnace (giving temperatures approximating those of the sun, namely, 3,000 to 3,500° Centigrade) white pig iron containing 5 to 6 per cent. of carbon and adding to it carbon from the crucible in which the iron is contained. This additional carbon is supplied by heating sugar until it decomposes, and that material is then put into the crucible as a lining, and at the very high temperature at which the iron begins to vaporize, the carbon lining of the crucible is taken up rapidly by the iron; after fusion a few minutes, the entire contents of the crucible are taken out and emptied into water. The quicker the cooling, the more likelihood of obtaining diamonds.

The best process discovered for cooling the diamond-yielding fusion is to empty the crucible suddenly into molten lead, kept just at the point of fusion; the iron solidifies into a tough skin on the surface, forming globules of iron an inch in diameter, but liquid, at an exceedingly high temperature, inside. The subsequent steps are the removal of this tough skin when formed and the cooling of the residue as slowly as possible. The removal of this solid wall of iron from the surface allows the interior mass to expand—as carbon expands when it crystallizes; and thus the carbon crystallizes out from the iron into small white diamonds not more than 1/6 of an inch in diameter, entirely water white, and which would be gems, if only large enough.

M. Moissan, who, in 1893, first succeeded in making white diamonds by the foregoing processes has also obtained a very large percentage of the black diamonds used for grinding purposes.

Since the above method of the formation of diamonds has been pointed out it has been found that diamonds occur in ordinary steel, but microscopic in their minuteness, and it is very probable that the hardness of certain steel is due to the actual crystallization of diamonds in the substance of the steel, and not entirely due to the formation of the iron carbide, the so-called cementite, which is the hardening of iron in the steel.

We find in nature diamonds have been formed under apparently the same condition. Many meteorites consist principally of metallic iron which contain diamonds; and another material, carborundum, while it has not been found occurring on the earth in nature, has been found in meteorites. It is a compound of carbon and silicon, and is now made artificially and used for grinding.

If sufficient care were taken, a very excellent gem could probably be made of carborundum. It cuts a ruby very easily and will scratch a diamond. The colors are generally blue and green.

Thus far, we may say, only the ruby and the spinel have been made to compete with the natural stone; but it may not be very far in the future when the diamond, of gem size, will be made artificially to compete with its prototype.

THE IDENTIFICATION OF BOTANICAL SPECIMENS.*

OF the large number of plant specimens which annually reach the pharmaceutical botanist from miscellaneous sources for determination, but a very small percentage are in such condition as to facilitate the operation; indeed, it is not too much to say that the cases are rare in which they are so prepared. This is doubtless due in but a small minority of cases to downright carelessness on the part of the sender.

Surely there are but few people who, in order to save themselves five minutes, would impose the loss of as many hours upon the one whom they were asking to perform a friendly service for them. To determine properly prepared specimens is not burdensome to the botanist who is in love with his work. Under ordinary circumstances it is a pleasure. He may in this way meet an opportunity of seeing something which he has never seen before, or at least of learning something new concerning it, even if it be nothing more than an added fact concerning its geographical or altitudinal range. If not so, still he is usually pleased to look again upon an old acquaintance. But to receive a mass of folded or tangled vegetation, perhaps dried in this condition, perhaps packed before drying and since become mouldy or rotten, or perhaps even broken up after drying so as to make it conform to the size of the envelope; often without flowers and still oftener without fruit, root or entire leaves so expanded as to show their natural form—this brings no satisfaction, and permits of a certain determination only after long and patient work in softening the mass and straightening it out into its original or natural form.

THE PRINCIPLES OF PLANT COLLECTING NOT WELL UNDERSTOOD.

A long experience in corresponding with the senders of such specimens renders it certain that they do so because they are not familiar with the conditions of determining them, and thus do not realize the burdensome results to their correspondent of neglecting some simple precautions. The botanical instruction in our pharmacy schools has been until comparatively recently so impractical in character that there is a very general lack of information among our practicing pharmacists of everything pertaining to the subject except the merest elements of book knowledge. It would seem as though our pharmaceutical journals might wisely devote a portion of their space to a continued and systematic effort toward teaching their readers how to collect, prepare and study plants. As a contribution in this direction I would offer the following explanation of the steps required for the determination of plant specimens.

THREE CLASSES OF SPECIMENS

may be recognized as depending upon variations in these conditions. Well known drugs, or the plants which yield them, constitute:

The First Class.—Of these there are but a few hundred, and the experienced pharmaceutical botanist may be supposed to be so familiar with them that he can recognize them in almost any condition. At the same time it is to be remembered that when they are comminuted or mixed, many hours of the most difficult labor are frequently called for to insure a positive identification. Still it may be admitted that the preparation of specimens of this class does not in general call for the precautions to be outlined below.

The Second Class.—Comprises the local flora of the immediate neighborhood where the botanist has lived. If the readers of the Druggist and Record—at least this is true of the ordinary uninitiated class—were asked to give an offhand estimate of the number of wild plants in their neighborhood, a majority would doubtless fix it in the neighborhood of 100. As a matter of fact, the number would range in different localities between 1,000 and 2,000. The specimen sent in may be any one of these, and when carelessly dried may closely resemble some very distant relative. Even in such a case, if the recipient is an active field botanist, and not merely one who has been led by the exigencies of circumstances to fit himself for giving a course of botanical lectures, he will not find any great difficulty in recognizing the major portion of such specimens.

The Third Class.—Comprises the very great majority of cases—those in which the specimen comes from a distance, representing a plant with which the recipient is no more likely to be familiar than with that of any other portion of the world, so that to be reasonably sure of recognizing it at sight would presuppose a complete familiarity with the world's flora of some 200,000 species, a thing which is obviously impossible for the human intellect. In these cases there is but one method open for the determination. A comprehensive work on the flora of the general region in which the plant grows must be used, and the identity of the latter must be traced step by step by a process of exclusion. If the country of its growth is not known, a universal work on family and genera must be used, and only the most perfect material and accurate work can lead to a correct result. Each step is like a railroad switch, which will either send one upon the right track or else hopelessly wrong, while if the material at hand does not afford the required information, the progress is blocked altogether. In these progressive steps the characters of the leaf, flower, fruit, ovule, seed and embryo succeed one another without regularity and each is in itself absolutely essential at some point.

MODE OF DETERMINING THE SPECIES.

We first decide whether the plant is one which bears flowers in the ordinary meaning of the term. If so, are its ovules inclosed in cells or are they naked upon scales? If the former, are its leaves parallel or netted veined? By this time we shall have excluded approximately half of the species and have to search only among the remainder. We then inquire if the flower possesses petals, and if so, whether they are entirely distinct or united with one another. Thus we proceed until it becomes necessary to ascertain what sort of a fruit the plant possesses and what are the characters of the seed contained therein. At length we are brought to a point where we must compare the general appearance of the plant with the descriptions of several in order to ascertain with which one of them it corresponds.

ALL PARTS OF THE PLANT SHOULD BE REPRESENTED.

From this outline of the process it is clear that in the most difficult cases it is indispensable, and in all cases of great assistance, to have all parts of the plant represented, unless it be a tree or a shrub, when a statement of its habit accompanying leaf, flower and fruit bearing twigs is sufficient. It is not a difficult thing for the one who desires the determination to visit the plant a second time and secure the fruit, having already collected the flowers. In any case the trouble to him does not compare in extent with that which will be caused his correspondent by a failure to take this course. Entirely aside from such considerations, it conduces to habits of accuracy and completeness to perform one's duties in this manner. Representative specimens being thus secured, they should be thoroughly dried before being forwarded. I recently received specimens from Yucatan, supposed to have been dried before being shipped, which have been planted and are now growing finely.

HOW TO PREPARE SPECIMENS.

The specimens should be dried in a perfectly flat condition, even the flower being flattened out so as to

* By Henry H. Rusby, M.D., Prof. of Botany and Materia Medica in the College of Pharmacy in the City of New York.—From the American Druggist and Pharmaceutical Record.

show the central parts, and some of the leaves should have their faces, others their backs uppermost. One minute is sufficient to put the plant in this position on a sheet of newspaper, which should then be folded over it and placed in a large book like a dictionary, or in the middle of a pile of papers, with 50 or 60 pounds weight upon it, to dry. If it is in the midst of a pile of papers measuring, when under pressure, 4 to 6 inches in height, it need not be looked at again until dry, provided it be left in a dry place. Otherwise it must be changed several times into dry papers when those containing it have become charged with moisture. This may be done twice a day with advantage for two or three times, afterward once a day until dry. There are, of course, various elaborate processes for preparing specimens in the most handsome condition, but this article is intended to indicate only what is necessary to facilitate the naming of the plant. When at length the specimen is dry it should be mailed, tightly tied between stout pasteboards so that it cannot be broken, without any writing except the name of the sender upon the outside, the postage upon such packages being one cent an ounce.

DETERMINATIONS OF HIGH TEMPERATURES.

Two methods for the estimation of the temperatures of furnaces, and for which are claimed the same degree of exactness, form the subject of an interesting note by Dr. H. Hecht, summarized below.

In the first method the instrument employed is the Le Chatelier pyrometer, which consists of a thermocouple of platinum and an alloy containing ninety per cent. of platinum and ten per cent. of rhodium. When the temperature of one of the points of junction is raised, a current passes through the circuit, its intensity varying with the difference of the temperatures of the joints. The force of this current is measured by a galvanometer placed in the circuit. When the instrument is calibrated by means of some fusion point already well established, or else by means of an air thermometer, it is ready for use.

Certain precautions should, however, be observed, and according to Dr. Hecht, the most necessary are: The resistance of the conductors leading to the galvanometer should not exceed one ohm, these conductors should be long enough to allow the exterior junction to remain nearly at the temperature of the surrounding air, the conductors be maintained at a certain distance and protected from the action of gases and carbon, inclosing them in capillary tubes of porcelain, and the galvanometer should be leveled and the needle made to return to zero as soon as the current ceases to pass.

This pyrometer presents the advantage over all the others that the readings may be made at a considerable distance from the furnace, whose operation, therefore, may be observed by the superintendent of the works without being personally present.

The cones of Seger constitute the second method employed in the determination of high temperatures. This method is especially adapted to the manufacture of tiles and porcelains, showing, as it does, the effect of time as well as the intensity of heat upon the material under operation. The size of the furnace and the rapidity with which the high temperature is attained affect the fusion point of the cones, as does also the oxidizing and reducing action of the flames. The highest melting points of the series are as a rule higher than will be met with in practice.

According to the average of results obtained in the very exact researches of Violle, Barus and of Holborn and Wien, the approximate melting poin's of certain metals are as follows:

	Fah.	Cent.
Silver	1778°	970°
Gold	1956	1069
Copper	1968	1076
Nickel	2724	1496
Palladium	2861	1572
Platinum	3282	1806

Hitherto the melting point of platinum has been considered as being 2,000° Cent. (3,632° Fah.)

Allowing that certain cones correspond with the melting points given above, it would appear that the interval between the melting points of the consecutive cones of the series would be 30° Cent. (54° Fah.) up to 950° (1742° Fah.), and 20° (36° Fah.) from that point up.

Cones 20 and 36 fuse respectively rather above the melting point of nickel and platinum, and calculating the temperature from the series with the intervals indicated above, these cones correspond to 1,530° Cent. (2,786° Fah.) and 1,850° Cent. (3,362° Fah.), which agrees approximately with the points of fusion of nickel and platinum according to the most recent determinations.

With these points in view, Dr. Hecht has made a table revising the melting points for the entire series of fifty-eight cones, and he proposes to substitute the temperatures of this table for those formerly applied to the cones. The figures in his table he confirms by comparison with Le Chatelier's pyrometer.

This last instrument, as well as the Seger cones, are employed in the manufacture of the royal porcelain of Berlin, in the glass works of Dr. Schott, at Jena, as well as in many other industries.

As a result of the labors of Dr. Hecht we may conclude that the temperatures of fusion hitherto attributed to the cones of Seger were too high.—Progressive Age.

From the latest government report (United States Geological Survey) by the leading American expert in gems, George F. Kunz, it appears that the United States produced in 1895 as follows: Diamonds valued at $250; sapphires, $9,057; rubies, $2,000; topazes, $1,000; phenacites, $1,050; tourmalines, $3,160; smoky quartz, $4,000; rock crystal quartz, $8,160; silicified wood, $4,000; andalusite, $1,000; garnet, $2,350; pipestone, $3,000; arrow points [of the kinds used as personal ornaments?], $1,000; agate, $2,000; turquoise, $50,000; moss agate, $1,500; fossil coral, $1,000; rose quartz, $1,000; gold quartz, $10,000; rutilated quartz, $500; utahite (compact variscite), $1,000; and numerous other minerals, the production amounting in value to less than the above. The aggregate value was $113,621, while the largest sum was in 1892, when the valuation was $312,050; in the sixteen years to 1895, the value ranged irregularly between this and $100,000.

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